SEMI AUX018-0710
FOUP/LOAD PORT INTEROPERABILITY REPORT

Foreword

Publication of this document as auxiliary information independent of any standards was authorized by a 2/3-majority vote of the Japan Physical Interface & Carriers Committee on April 8, 2010. This action was also approved by the global Physical Interface & Carriers Coordinating Subcommittee by electronic ballot on April 26, 2010; and by the global Audits & Reviews Subcommittee on May 21, 2010.

The information in this document has been furnished by the 300 mm Carrier Task Force comprised of participants from the equipment, carrier, and loadport suppliers, and IC makers from Europe, Japan, North America and Taiwan. This study group developed the report under the SEMI Standards Physical Interfaces & Carriers Committee, working cooperatively between regions.

In the course of evaluation of 300 mm FOUP and loadport implementations, numerous problems have been found. These problems included some noncompliance to the SEMI Standards for physical interfaces, but some problems were system oriented, and, thus, required study of the integration of FOUPs and loadports for solutions. As the problems were internationally recognized, device makers decided to define their requirements to ensure interoperability between FOUPs and loadports in a User System Requirements Document (USRD) for FOUP-to-Loadport Interoperability developed by J300E and International SEMATECH and announced at SEMICON Japan 1999.

International FOUP/Load Port Interoperability Study Group was established to identify the source of interoperability problems, publish the analysis results of the problem, create action plans, and suggest standards activities needed to enhance the maturity of the standards. The results of the study are intended to provide additional implementation guidance to suppliers to ensure interoperability within compliance to all relevant SEMI Standards. A report from the Study Group was presented at an International Workshop on FOUP-Loadport Interoperability July 13, 2000. The present document is an updated version of the report presented in July.

Subsequently, minor revisions to the material have occurred since its initial publication in December of 2000, reflecting changes and advances in the industry. The material within this auxiliary document reflects these changes, with no substantive additions being made.

In February of 2010, this document was re-examined by the global Physical Interfaces & Carriers Maintenance Task Force and revised accordingly. These revisions include the addition of information on FOUP door drop prevention.

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SEMI
FOUP-Load Port Interoperability Implementation Recommendations
Revision 1.06

April 8, 2010

Global PIC Maintenance Task Force

PI&C Committee

Revised Page

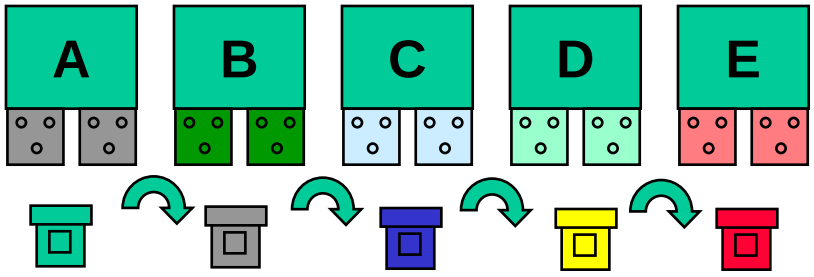
Contents

Overview

- The FOUP has been thought to be utilized as the standard carrier for the 300mm fab, and tremendous amount of effort was invested to bring about 300mm standardized carrier.
- Numerous problems have been found in the course of evaluation of mini-environment systems (i.e., FOUPs and Load Ports).
- These problems include some simple non-compliance to the standards, but some are system oriented, and, thus, require “share of responsibilities” between FOUPs and Load Ports for solution.
- As the problems were internationally recognized, device makers decided to show their requirements to ensure interoperability between FOUPs and Load Ports.
- The first FOUP/Load Port Interoperability International Workshop was held at SEMICON Southwest 1999.
- This activity was followed by publication of a User System Requirements Document (USRD) for FOUP-to-Load Port Interoperability developed by J300E and International SEMATECH and announced at SEMICON Japan 1999.
- In the response to USRD International SEMI FOUP/Load Port Interoperability Study Group (hereafter FLI SG) was formed.
- FLI SG objective is to publish the analysis results of the problem, create action plans, encourage TF formation to the problem, and enhance the maturity of the standards.

Background

- The required "interoperability of FOUP/Load Port" is NOT only the capability to be able to open FOUPs from multiple manufactures.
- The interoperability requirements include following view points:
  - any Load Ports from multiple suppliers can open any FOUPs from multiple suppliers as shown in the figure on right hand side of this foil.
  - repeatability: the FOUP Door position can increasingly deviate from the most preferred center position as processing goes on and may result in interoperability loss since the FOUP Door position depends on the previous closing operation.
- This is a real challenge in an effort to implement 300mm mini-environments in an automated production line, which we can not predict from results in the early methods like "single Load Port vs. single FOUP many open/close cycle test."
- In order to encourage standard compliance and data feedback for FOUP/LP improvement, FLI SG decided to publish an interoperability recommendation report consisting of two volumes:
  - Measurement Methods for FOUP and Load Port
  - Interoperability Implementation Report



N FOUPs vs. *M* Load Ports situation

Background (continued)

- **Interoperability Implementation Report**
  - The FOUP Load Port Interoperability SG decided to divide the requirements into 3 categories so that reasonable solution can be obtained:
    - FOUP
    - Load Port
    - System
- **Measurement Methods**
  - The FOUP Load Port Interoperability SG decided to divide the requirements into 2 categories:
    - FOUP
    - LP

Objective

- Objective of "FOUP-Load Port Interoperability Implementation Recommendations"
  - Alert suppliers and/or add minimum additional requirements to ensure interoperability while assuring compliance to all relevant SEMI Standards.
  - Give complementary explanation of standards and/or concrete explanation of proper operation of FOUPs and Load Ports
  - Identify the potential areas of concern and may provide several possible design recommendations.
  - Propose corresponding TF activities.
    - c.f. Purpose of standards are to define the minimum requirements to enable interoperability
  - Each item in "FOUP-Load Port Interoperability Implementation Recommendations" should have an outcome which may suggest changes to existing standards or inclusions in SEMI Guide, etc.

Reflection Philosophy to Standards

- How to reflect the report recommendations to SEMI documents:
  - Put in corresponding standards (E47.1 or E62) as application notes for the best appeal as long as the issue is closely related to one of each documents.
  - Include high level items such as system view for interoperability in a SEMI Guide.
    - It is proposed to publish all the detailed recommendations in a separate SEMI Guide like the I300I Mini-Environment Best Practices Document while the necessary changes in SEMI Standards are added to the SEMI Standard body.
- General Comment
  - In case difference of philosophy on standard exists, suggestions from regional SGs may be listed.

USRD

- User System Requirements Document for FOUP-to-Load Port Interoperability
  - (1) E62-y33 Variation for FOUP & Load Port
  - (2) FOUP and Load Port Door/Frame Size Relation
  - (3) Repeatability of FOUP Door Position
  - (4) Gap between FOUP and Load Port Frames
  - (5) Accuracy of Wafer Location
    - Study Requirement
    - Latch Key Operation

History of Report Development 1

- Oct./99 Kick off at SEMICON/Southwest '99
- Dec./99 FTF meeting for review of first draft at SEMICON/Japan
- March/00 FTF meeting for review of draft R0.08 NA at winter meeting in La Jolla
- 4/18-19/00 VC for review of draft R0.12
- 5/15-16/00 VC for review of draft R0.13
- 5/16/00 With comments from North America/Europe/Korea/Taiwan FOUP-Load Port Interoperability SG meeting
- 5/17/00 With Japan FOUP-Load Port Interoperability SG comments
- 5/17/00 With comments from International SEMATECH
- 6/1/00 With comments from North America/Europe/Korea/Taiwan FOUP-Load Port Interoperability in SG meeting at SEMICON Kansai
- 6/8/00 With comments from North America/Europe/Korea/Taiwan FOUP-Load Port Interoperability in SG meeting at SEMI Japan

History of Report Development 2

- 6/22/00 With comments from North America/Europe/Korea/Taiwan FOUP-Load Port Interoperability in video SG meeting
- 7/12/00 Present this report at International Workshop on FOUP-Load Port Interoperability
- 7/13/00 Proposal of Auxiliary Document publication at NA PIC committee at SEMICON West
- 12/8/00 Pass Auxiliary Document publication at JP PIC committee at SEMICON JAPAN
- 2/21/01 Doc. 3352 AUX006-0201 : User Interface Configurations for 300 mm Equipment Load Ports
- 7/13/01 Approval to revision of Auxiliary Document at NA PIC committee.
- 12/5/01 Approval to revision of Auxiliary Document at JA PIC committee at SEMICON JAPAN.
- 4/10/03 Proposal to revision of Auxiliary Document at JA PIC committee.

History of Report Development 3

- 10/15/03 Proposal to revision of Auxiliary Document at NA PIC committee.
- 11/15/04 Proposal to revision of Auxiliary Document at NA PIC committee.
- 04/08/10 Proposal to revision of Auxiliary Document at JA PIC committee.

Acronyms

- AMH Automatic Material Handling
- AMHS Automatic Material Handling System
- BDP Bilateral Datum Plane
- CMM Coordinate Measurement Machine
- FDP Facial Datum Plane
- FIMS Front-opening Interface Mechanical Standard
- FOUP Front Opening Unified Pod
- HDP Horizontal Datum Plane
- KC-Pin Kinematic Coupling Pin
- KC-Plate Kinematic Coupling Plate
- LP Load Port
- SG Study Group
- TF Task Force
- Those words defined in SEMI Standards are expressed in capital letters for the initials.

New Page

450mm FOUP-Load port

- This report is a material to assist the realization of 300mm FOUP-Load port（300mm system）interoperability.
- 450mm FOUP-Load port（450mm system）uses front-opening method, rotary latch method, and kinematic coupling FOUP positioning method etc. like 300mm system, so the philosophy of interoperability described in this report can be reflected onto 450mm system.
- It is recommended to apply this report effectively to 450mm system.
- Note :
  - ♦Note that this report is for 300mm FOUP-Load port, and names, marks and dimensions, etc in are different from those for 450mm FOUP-Load port.
    - Example: The name of Registration Pins for 300mm system is changed to Door Pins for 450mm system.

Volume 1
Interoperability Implementation

Report Development Process

- Step 1: Create a report draft for all issues under discussion by FLI-SG
  - To: Provide status on the discussions regarding the items in the latest report draft.
  - How: FLI-SG to post the report draft on web-site

- Step 2: Suggest creation of / delegation to TFs for possible standard amendments
  - Types of standard amendments:
    - Change standards to remove contradiction
    - Add some definition to standards
    - Narrow the definition in standards
    - Add application note

- Step 3: Remaining items in the report draft after Step 2 may be balloted per SEMI regulation to become a SEMI Guide

Position of Document

- This report has been developed by international collaboration at following TF/WG.
  - E47.1 TF
  - E62TF
  - International FOUP-Load Port Interoperability Study Group
  - International 300mm Carrier TF
  - Global PIC Maintenance TF
- TF to work on:
  - Convert suggestion of additional application notes in the report into ballots for appropriate inclusion in SEMI Standards.
  - Convert suggestion of additional requirements in the report into ballots for appropriate inclusion in SEMI Standards.
  - There are some suggestions in the report such as “gap model” and “FIMS Door Return Accuracy Requirement” which are left to TF to work on corresponding concrete numerical values.

Format Description for Implementation Report

- Template of an individual issue foil
  - Related USRD:
    - List related USRDs. (ex. 3. Repeatability of FOUP Door position)
  - Requirement:
    - List SEMI level requirements
  - Related Standards:
    - List related SEMI Standards and parameters
  - Impact to Standards:
    - List impacts such as delete, modify, add, application notes.
  - Application Note:
    - Application Notes to apply this recommendation
  - Background:
    - List problems and rationales of this recommendation.
  - Approach:
    - List approaches/concepts to solve the problem and put the reason why above approach is chosen.
  - Note:
    - Miscellaneous notes

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  - FOUP: FOUP should accept Latch Key under E62 Force Specs
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  - Load Port: Minimum Door Closing Force Definition
  - Load Port: Dock Holding Force should be larger than Door Open/Close Force
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Registration Pins Functionality

USRD: 3. Repeatability of FOUP Door Position

System: Registration Pins Operation

E62: Added to Application Note

- **Related USRD:**
  - 3. Repeatability of FOUP Door Position
- **Requirements:**
  - Do not use Registration Pins for FOUP Door lead-in to the Load Port Door.
  - Registration Pins should be used to limit maximum displacement of the FOUP Door while on the Load Port Door.
- **Related Standards:**
  - E62: d31, x31, z31, r30
- **Impact to Standards:**
  - Neither the FOUP nor FOUP Door positions should change as a result of engaging or disengaging Registration Pins. Rewording is recommended for the Registration Pin description in SEMI Standards, as is having an Application Note describe this issue.
  - When the Load Port experiences utility loss (such as EMO, vacuum loss, electrical failure, etc.), Registration Pins may be used to maintain the FOUP Door's position, and to ensure the FOUP Door not to fall off.
- **Background:**
  - Kinematic Coupling and Clamp mechanism primarily restrict six degrees of freedom of the FOUP. Door alignment by Registration Pins causes over-constraint of the FOUP to the Load Port, and this should be avoided.
  - High friction caused by over-constraint may cause particle generation.
- **Approach**
  - The Load Port does not align the FOUP Door to the Load Port Door but keeps its position as it was.
  - Method will be an implementation issue. Vacuum holding or Latch Key grip with friction may be examples.
- **Note:**
  - This recommendation is only related to usage of Registration Pins for the purpose of lead-in (guiding the FOUP Door onto the Load Port Door), which may very probably cause an over-constraint. Once the FOUP Door is registered on the Load Port Door, Registration Pins may be used to maintain the position of the FOUP Door once removed from the FOUP.

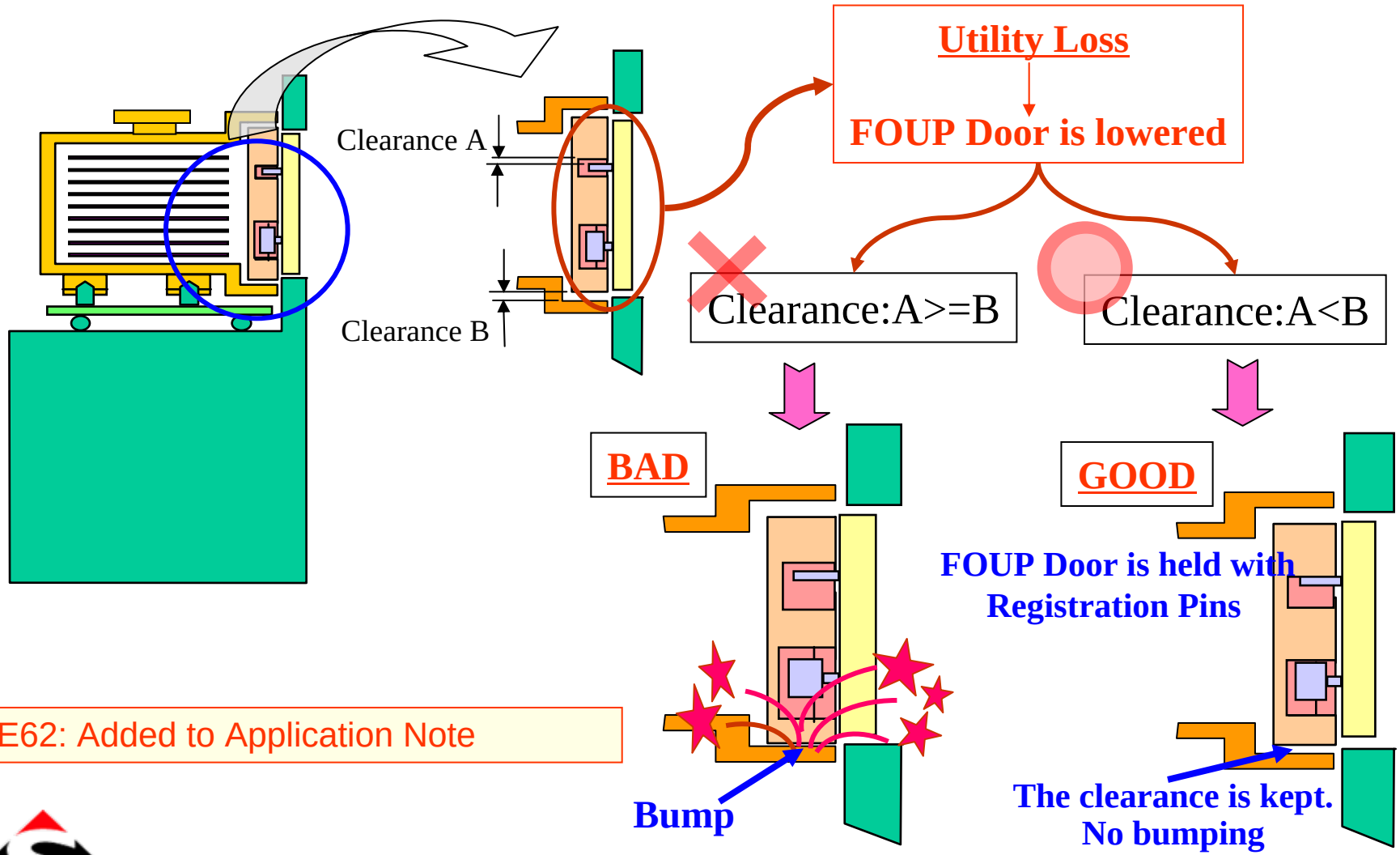
System: Recovery from Utility Loss Should be Done Without FOUP Frame to FOUP Door Interference

- **Related USRD:**
  - 2. FOUP and FIMS Door/Frame Size Relation
  - 3. Repeatability of FOUP Door Position
- **Requirement:**
  - The FOUP Door should be returned safely to the FOUP (with no bumping, no scraping, etc.) during recovery from any utility loss that might occur while the FOUP Door is open.
- **Related Standards:**
  - E62 Registration Pins shape
- **Impact to Standards:**
  - None.
  - See Note.
- **Application Note:**
  - The clearance between the Registration Pins and the Registration Pin Holes should be less than the clearance between the outer edge of the FOUP Door and the inner edge of the FOUP Door Frame. Balancing these tolerances is a FOUP design issue related to the E62 Seal Zone specification.
  - Registration Pin Holes locations should be designed with consideration to above tolerances.

- **Background:**
  - Utility loss (such as EMO or electrical failure) may result in a loss of the FOUP Door position while on the Load Port Door.
  - In this situation, the FOUP Door may not be able to be closed automatically if the FOUP Door position changes.
  - For cleanliness reasons, the FOUP Door support during utility loss should be considered to avoid human interruption.
- **Approach:**
  - the Load Port to have Registration Pins per E62.
  - the FOUP to have appropriate size of Registration Pin Holes to prevent excessive FOUP Door displacement when utilities are lost.
- **Note:**
  - JA SG thinks this should be included in Application note of E47.1 whereas NA SG thinks this should be in SEMI guide.

E62: Added to Application Note

The clearance between Registration Pins and Holes should be less than the clearance between FOUP Door and Frame.



E62: Added to Application Note

Load Port: Load Port Must Provide Registration Pins per SEMI E62

- **Related USRD:**
  - 3. Repeatability of FOUP Door Position
- **Requirement:**
  - the Load Port must provide Registration Pins compliant with SEMI E62: (d31 etc.)
- **Related Standards:**
  - E62: d31, x31, z31, r30
- **Impact to Standards:**
  - None.
  - Compliance required with E62.
- **Application Note:**
  - Registration Pins may be used to enable non-interference error recovery from lost position due to utility loss.
- **Background:**
  - Due to several Load Ports in production having non-compliant Registration Pins to avoid over-constraint, these recommendations were developed to serve as an implementation guide for using SEMI Standard equipment.
  - Registration Pins are not appropriate for FOUP Door positioning to the Load Port Door.
  - Registration Pins should be used to limit the maximum displacement of the FOUP Door while it is engaged onto the Load Port Door.
- **Approach:**
  - Non-interference error recovery from position loss due to power loss should be considered.
- **Note:**
  - Common non-compliances and reinforcement messages may be collected as a section in some SEMI Guide Document or the like.
  - Registration Pins may be used as reference points to measure the Load Port Door position and features.

E62: Added to Application Note

FOUP: FOUP Should Have Appropriate Size Registration Pin Holes

- **Related USRD:**
  - 3. Repeatability of FOUP Door Position
- **Requirements:**
  - The FOUP should have Registration Pin Holes of an appropriate size to avoid over-constraint caused by the positioning error resulting from possible FOUP tolerances (not defined in SEMI Standards) and Registration Pin tolerances (defined in E62.)
  - The relation between Registration Pin Holes size and the FOUP Frame to FOUP Door gap should be considered to enable non-interference error recovery from lost position of the FOUP Door due to utility loss.
- **Related Standards:**
  - E62: d31, x31, z31, r30
- **Impact to Standards:**
  - None.
- **Application Note:**
  - The clearance between the Registration Pins and the Registration Pin Holes should be less than the clearance between the outer edge of the FOUP Door and the inner edge of the FOUP Door Frame. Balancing these tolerances is a FOUP design issue related to the E62 Seal Zone specification.
  - The diameter of the Registration Pin Holes should be designed to accommodate the Registration Pin tolerance defined in E62 (x31, z31, d31) and the Registration Pin Hole location tolerance in a FOUP.
- **Background:**
  - Registration Pins are not appropriate for FOUP Door positioning to the Load Port Door.
  - Registration Pins should be used to limit the maximum displacement of the FOUP Door while it is engaged onto the Load Port Door.
- **Approach:**
  - Non-interference error recovery from position loss due to power loss should be considered.
- **Note:**
  - It is proposed to add a note to the SEMI Guide to alert FOUP suppliers of design considerations when determining the size of the hole for Registration Pins while adding an Application note to SEMI E47.1.

E62: Added to Application Note

FOUP Door Return and Centering

USRD: 3. Repeatability of FOUP Door Position

Load Port: FIMS Door Return Accuracy Requirement

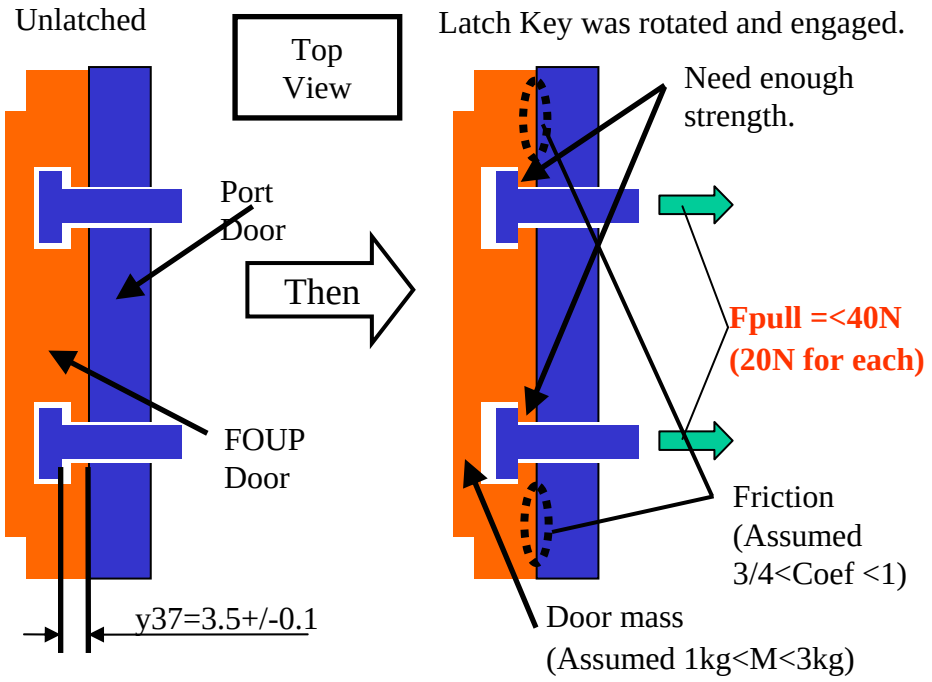
E62:Added 5.10 FIMS Door return repeatability

- **Related USRD:**
  - 3. When closing the FOUP, the Load Port must return the FOUP Door to the same location from which it was taken.
- **Requirement:**
  - The Load Port should return the Load Port Door to the position where the Load Port Door was within an accuracy that should be determined in the relevant TF.
- **Related Standards:**
  - E62
- **Impact to Standards:**
  - No contradiction.
  - Better to add Load Port Door return accuracy in E62.
  - E62 Rev. TF should work out the followings:
    - Need to revise E62 (Figure 1, for example) to clarify how the Load Port Door repeatability is to be included in dimensions.
    - Specify requirement only for X and Z directions in this Standard ammendment.
    - There needs to be clarification of the FOUP Door to the Load Port Door repeatability.
- **Application Note:**
  - Example of FOUP Door holding
    - Vacuum holding
    - Clamping by Latch Key with friction.
- **Background:**
  - To avoid the FOUP Frame from contacting the FOUP Door during FOUP Door closing, at least the FOUP Frame to FOUP Door clearance (dynamic) or the FOUP Door return accuracy by the Load Port must be defined.
  - Displacement should be as small as possible to avoid particle generation due to the FOUP Door sliding in the FOUP Frame.
  - The FOUP is expected to keep its Door centered to prevent the FOUP Door from creeping due to accumulation of Door return position errors.
  - The current +/-0.1mm FIMS Door per E62 (x30, x31, z30, z31) is to be further examined from the view point of tolerance and repeatability. The question here is if E62 intends to include the Load Port Door return repeatability tolerance.
- **Approach:**
  - Define the Load Port Door return accuracy of the Load Port.

FOUP: FOUP Strength around Latch Key Holes

E62:Added 5.11 Latch Key Retention force

- **Related USRD:**
  - 3. Repeatability of FOUP Door Position
- **Requirement:**
  - Regardless of the FOUP Door holding mechanism (vacuum chuck, Latch Key clamping, etc.), the FOUP Door strength around the Latch Key Holes should be designed to have an appropriate value.
- **Related Standards:**
  - E62:f35 , E47.1
- **Impact to Standards:**
  - No contradiction to current Standards
  - E47.1 TF worked on this issue to add strength definition compatible with the pulling force for clamping by Latch Keys.
    - Fpull =< 20N for each key (40N in total)
- **Application Note:**
- **Background:**
  - The Load Port should return the FOUP Door to the position where the FOUP Door was.
- **Approach:**
- **Note:**



FOUP: FOUP should have Door Centering Capability

- **Related USRD:**
  - 2. FOUP and Load Port Door/Frame Size Relation
  - 3. Repeatability of FOUP Door Position
- **Requirement**
  - The FOUP should have a capability to roughly center the FOUP Door in the FOUP Frame during the FOUP Door close sequence (during either return of the FOUP Door and/or during latching of the FOUP Door).
  - This centering capability should keep the clearance between the FOUP Frame and the FOUP Door larger than sum of the FOUP (self) tolerance and the E62 Registration Pin tolerance along with the FOUP Door's circumference.
- **Related Standards:**
  - E62-z33, z34, x33, x34
- **Impact to Standards:**
  - None (See Note).
- **Application Note:**
  - The intention of this recommendation is not to imply an accurate centering toward an ideal center but to keep the FOUP Frame to FOUP Door clearance appropriate for Latch Key insertion into the FOUP Door.
  - Candidate examples may include centering by latch motion and centering by slope between the FOUP Frame and the FOUP Door.
- **Background:**
  - There is an over-constrain issue between the "FOUP Door Return to the same position" function of the Load Port and the "FOUP Door centering" function of the FOUP. This expected to be solved within the mechanical compliance of both the FOUP and the Load Port.
  - Even though the Load Port Door tries to return the FOUP Door to the position where it was, accumulation of system error can occur, and, the FOUP Door may creep to hit the FOUP Frame.
- **Approach:**
  - The Load Port has a function to return the FOUP Door where it was and cannot have a centering function at the same time.
  - The FOUP is expected to keep the FOUP Door centered to prevent Door creeping due to an accumulation of Door return errors.
- **Note:**
  - It is recommended that the FOUP Door centering function be highlighted as an Application Note in E47.1.
  - It is believed that most FOUPs already have this.

E47.1: Added application note

FOUP Door Miss-Catch

1: E62-y33 Variation for FOUP & Load Port

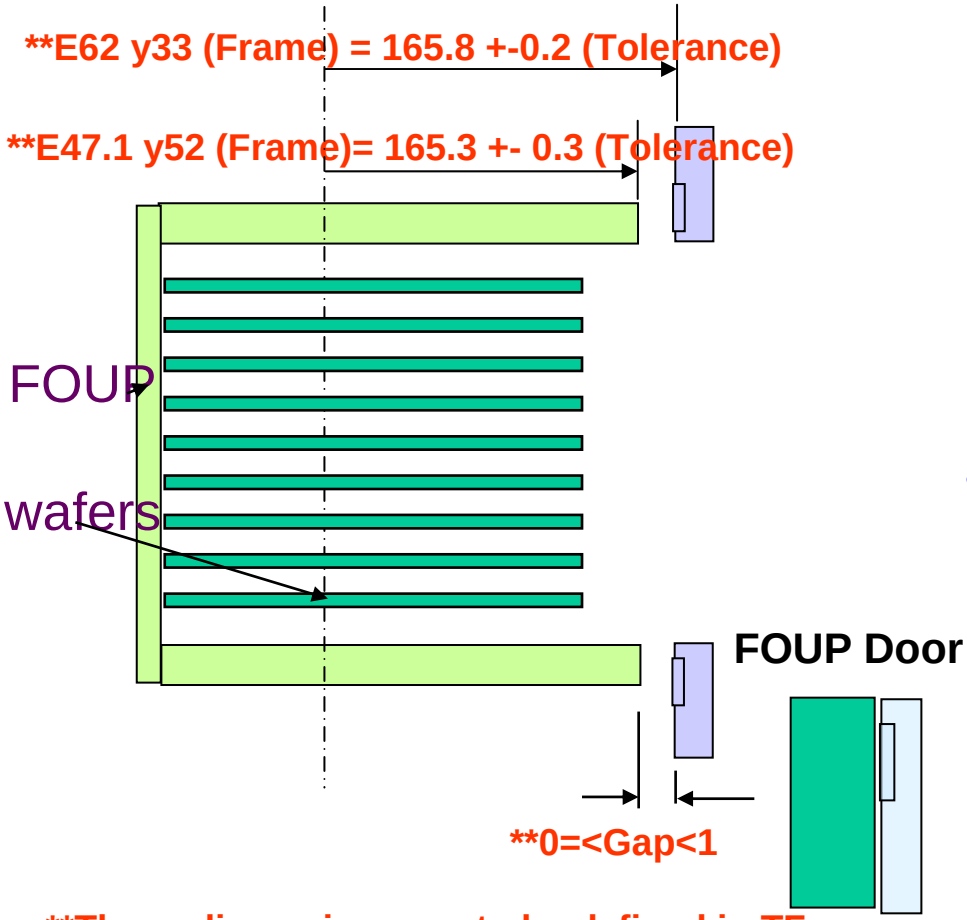
E47.1:y52 was changed 166mm Max. to 165.5+/- 0.5mm
E62:y33 was deleted

Load Port: Gap control between FOUP and Load Port Frames

- **Related USRD:**
  - 1: E62-y33 Variation for FOUP & Load Port
- **Requirements:**
  - The gap between the FOUP Frame and the Load Port Frame when a FOUP is docked and opened should be controlled less than the minimum value deduced from relevant tolerances.
    - The gap can be zero in the case of "Soft Contact."
  - The range of this gap should be discussed in joint TF of E47.1 and E62.
- **Related Standards:**
  - E62-y33:Frame
  - E47.1-y33 (y52) :Frame
- **Impact to Standards:**
  - TF to propose an application note that clarifies the relation between y52 (frame) in E47.1 and y33 (frame) in E62.
  - TF to create a consistent gap model in which relevant dimensions and operation are shown. See the figure in the following page
  - E47.1 TF to propose of an application note regarding y52 (Frame) in E47.1.
- **Application Note:**
  - The current standard individually gives y33 (FOUP Frame) and y33 (Load Port Frame) tolerances of +/-0.5mm and +/-0.5mm, respectively. Since these tolerances are independent to each other, the Load Port has to advance the FOUP so as to have the nominal FOUP Frame location at 1mm before the nominal Load Port Frame location in order to avoid a collision between Frames.
  - It can be that the actual FOUP Frame plane is 0.5mm before the the nominal location and, at the same time, that the actual Load Port Frame plane is 0.5mm further into equipment from the nominal location. This situation will give a 2mm wide gap, and which is thought to be too large.
- **Background:**
  - The system is required to be designed to leave a gap between the FOUP Frame and the Load Port Frame to avoid a collision between the two when the FOUP is docked (soft contact is OK).
  - The reasons are to prevent:
    - 1. wafer center location displacement from docked FDP.
    - 2. particle generation from rubbing between the FOUP Frame and the Load Port Frame.

Load Port: Gap control between FOUP and Load Port Frames(continued)

E47.1:y52 was changed 166mm Max. to 165.5+/- 0.5mm
E62:y33 was deleted



**These dimensions are to be defined in TFs.

- **Approach:**
  - Since the variation of y33 (Load Port Frame)and y52 are found to be within +/- 0.2mm in most of the currently available LPs and FOUPs, it is profitable to require the tolerance of y33 (FOUP Frame) to be much smaller in value to assure interoperability.
  - If we are to design the system with the nominal gap width to be 0.5 +/-0.5mm, the tolerances in y33 of the current standard should be halved in value.
- **Note:**
  - The system is required to be designed to leave a gap between the FOUP Frame and the Load Port Frame to avoid a collision between the two when the FOUP is docked (soft contact is OK).
  - The reasons are to prevent:
    - 1. wafer center location displacement from docked FDP.
    - 2. particle generation from rubbing between the FOUP Frame and the Load Port Frame.
  - The dimensions may be defined in a joint TF to resolve this systematic problem.

Load Port: FOUP Door to Load Port Door Miss-Catch Prevention by LP

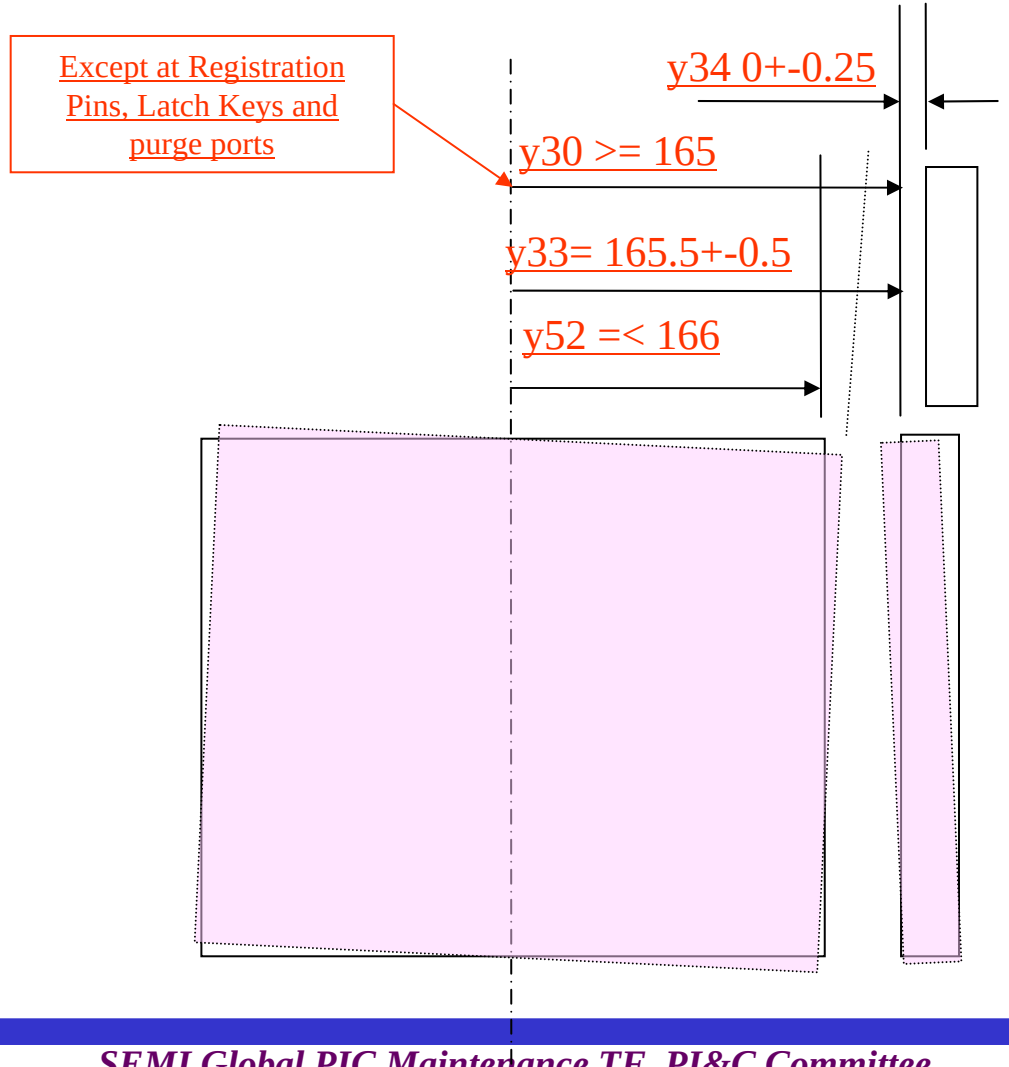
E62:y33 ,y34 were deleted.

- **Related USRD:**
  - 1: E62-y33 Variation for FOUP & Load Port
- **Requirement:**
  - The Load Port should have a function to absorb variation in the FOUP Door surface position (facing the Load Port Door) due to the tolerance of the FOUP and the Load Port in order to prevent a miss-catch of the FOUP Door by the Load Port Door.
- **Related Standards:**
  - E62-y33
  - E47.1-y33 (y52)
- **Impact to Standards:**
  - Remove y33 in E47.1.
  - Propose an application note that clarifies the relation between y52 in E47.1 and y33 in E62.
  - Create a consistent gap model in which relevant dimensions and operations such as door catching can be analyzed and explained.
  - In addition, JP-SG proposes
    - y33 in E62 has to be redefined as “compliance range” for rather than “tolerance”as is currently defined.
    - Generate a proposal of an application note regarding y52 in E47.1.
  - In addition, NA SG proposes;
    - Generate a proposal for clearly defining the FOUP dimension range currently referenced from y33.
    - Also include an Application Note about FIMS cushioning ability from USRD.
- **Application Note:**
  - An angular variation compliance function may be needed.
- **Background:**
  - Due to the following factors, the FOUP Door and the Load Port Door may cause a miss-catch;
    - Tilt of the FOUP Door
    - Distribution of y52 along the FOUP Door surface
    - Tilt of the Load Port Door
    - Docking stroke repeatability
- **Approach:**
  - The Load Port must absorb this mismatch because the FOUP has a bigger restriction on its tolerance improvement.
  - Relative errors such as system alignment error in E62 should also be absorbed by the Load Port side which is more flexible to design.
- **Note:**
  - This function may have influence on the FOUP Door holding repeatability of the Load Port. Careful design is required.

Load Port: FOUP Door to Load Port Door Miss-Catch Prevention by LP (continued)

E62:y33 ,y34 were deleted.

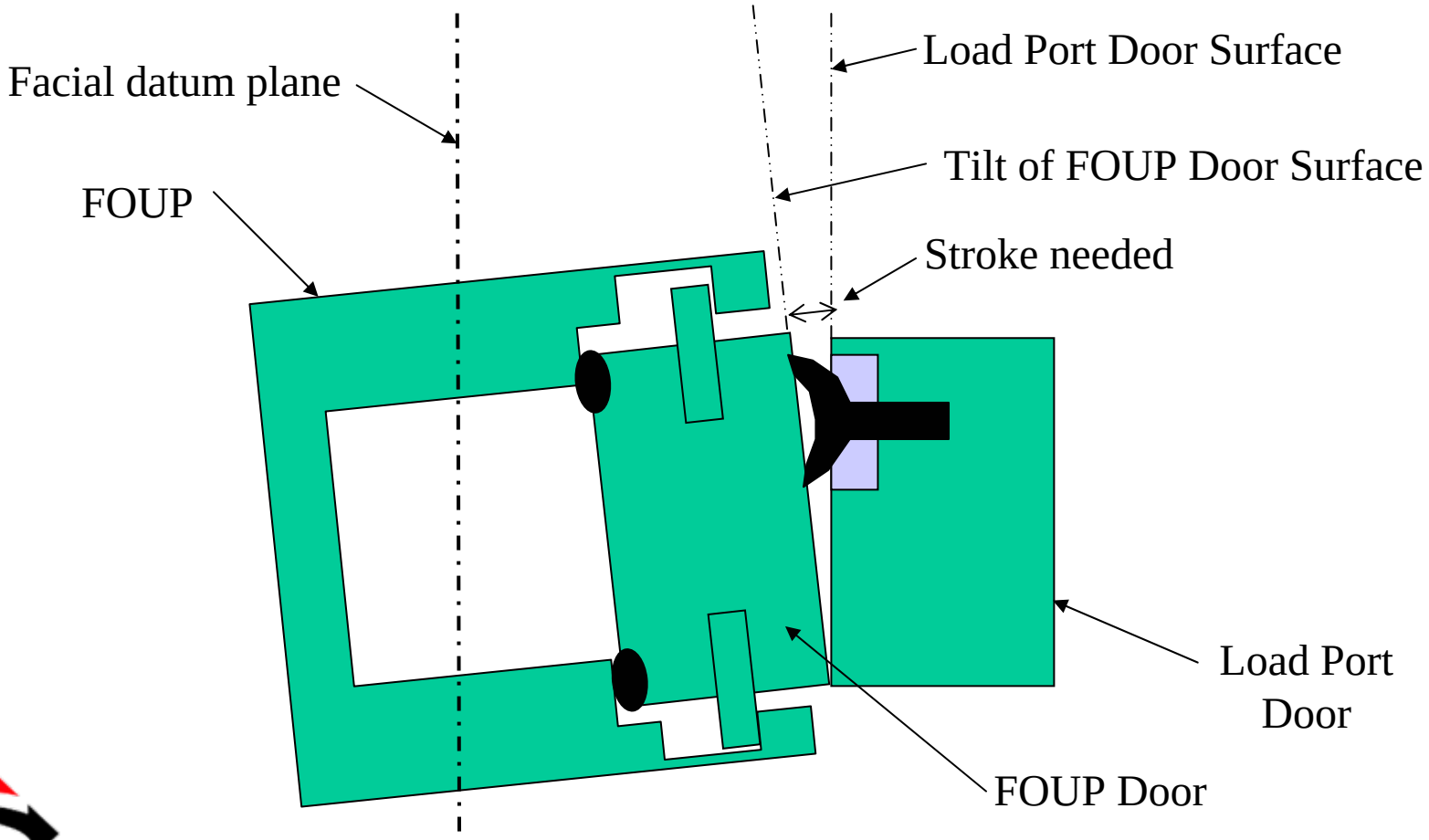
FOUP-Load Port Position Model by current Standards



Load Port: FOUP Door to Load Port Door Miss-Catch Prevention by LP (continued)

E62:y33 ,y34 were deleted.

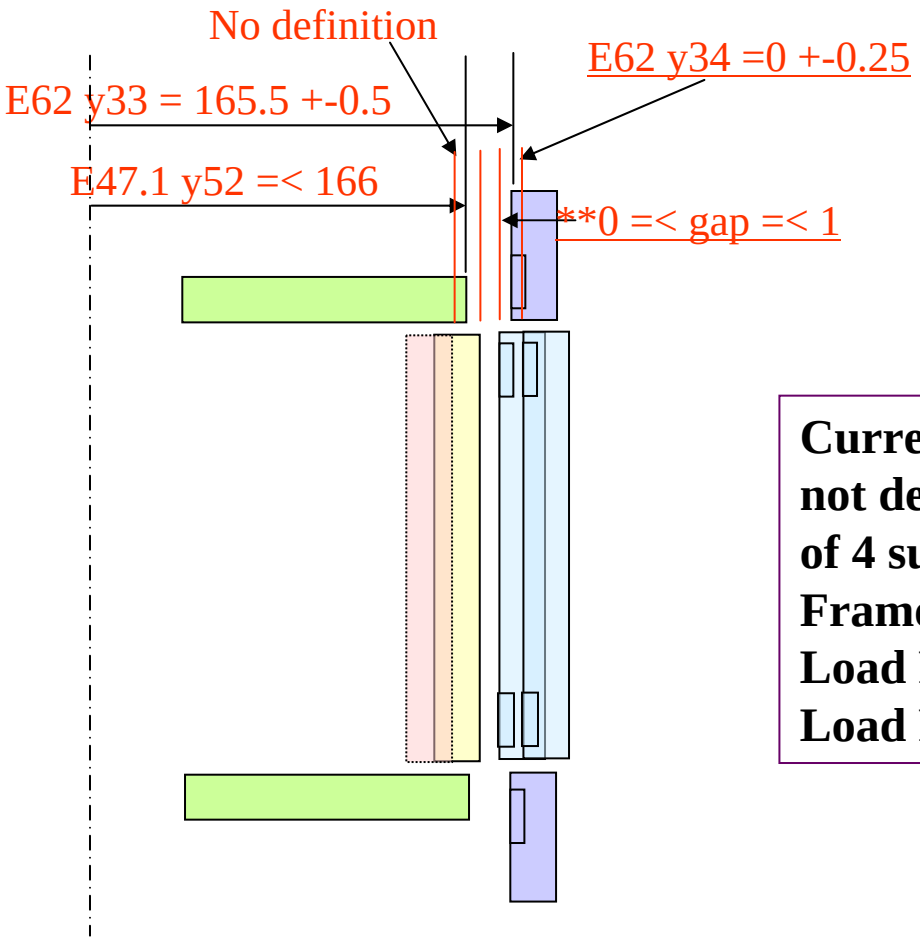
FOUP Door - Load Port Door Miss-Contact Absorption Model



Load Port: FOUP Door to Load Port Door Miss-Catch Prevention by LP (continued)

E62:y33 ,y34 were deleted.

Gap Model by Current Standards

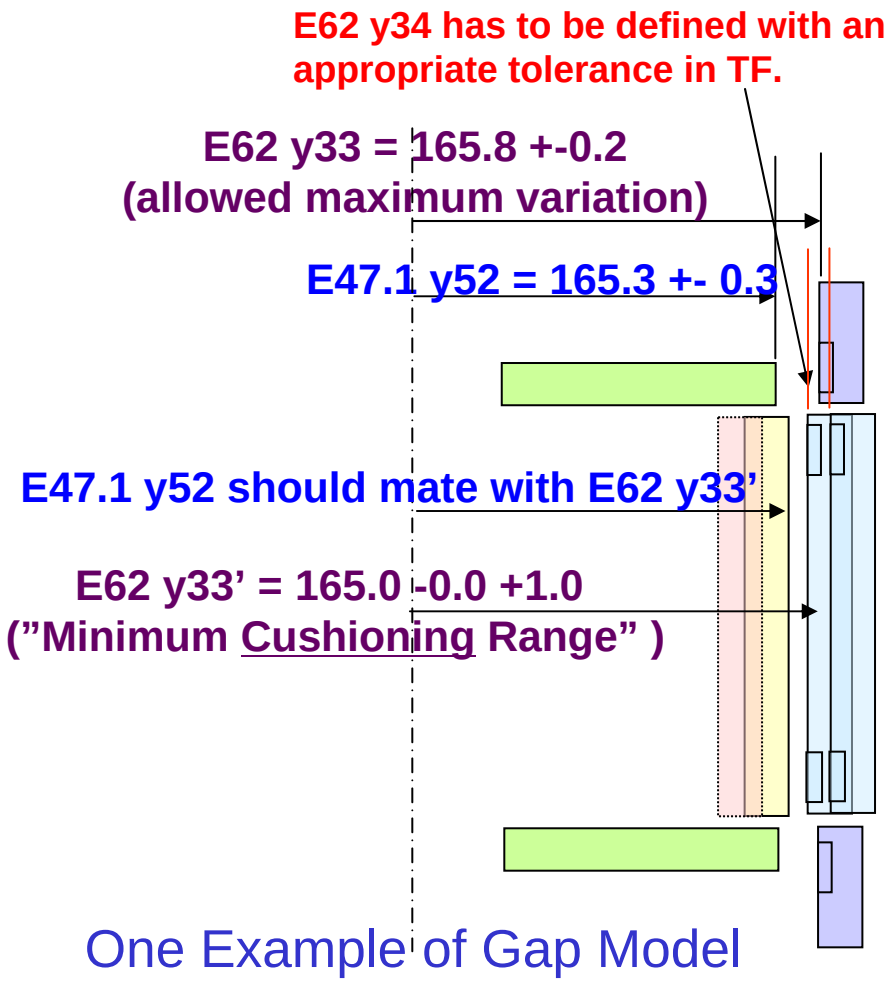


Current Standards do not define relationship of 4 surfaces (FOUP Frame, FOUP Door, Load Port Door, and Load Port Frame)

**These dimensions and names are to be defined in TFs.

Load Port: FOUP Door to Load Port Door Miss-Catch Prevention by LP (continued)

E62:y33 ,y34 were deleted.



One Example of Gap Model

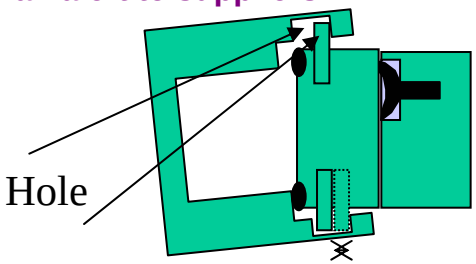
**These dimensions and names are to be defined in TFs.

- **Note:**
  - Since Frames are not in contact as described in the Frame Gap Model, the Doors have to be in contact to ensure the FOUP Door catch by the Load Port Door (with Latch Keys fully inserted for proper Latch Key Operation).
  - To ensure this Door contact, the system has to be designed to allow overlapping of the Load Port and the FOUP Door planes, but the current Standard allows the overlapping as much as from -1mm to +1mm.
  - This negative value in overlap means no Door contact, and this definitely has to be avoided. This leads to the following requirements:
    - The system has to be designed only to have a positive overlapping value.
    - The system has to be designed to absorb this positive overlapping.
  - To ensure #1 criteria, either side can be defined, but from *One-Sided Definition Policy* we should define the Load Port side y33 (E62 y33') for the Load Port Door to protrude out of Load Port Frame.
  - #2 criteria is to be embedded into E62 y33' as a"Cushioning Range."
  - FOUP suppliers need to design their FOUP Door to mate with E62 y33' or Door Gap Model.

E47.1:clarified to y52 ,

FOUP: FOUP to Have Enough Door Latch Allowance

- **Related USRD:**
  - 1: E62-y33 Variation for FOUP & Load Port
- **Requirement:**
  - The FOUP should have enough allowance in Door Latch engagement so that the Door Latch works under possible miss-alignment of the FOUP Frame and the FOUP Door due to the FOUP tolerance and the Load Port tolerance defined in E62.
- **Related Standards:**
  - FOUP E62-y33
  - E47.1
- **Impact to Standards:**
  - None.
- **Application Note:**
  - Examples of possible error which should be taken care of by the FOUP
    - FOUP Door tilt (parallelism error)
    - FOUP Door warp (flatness error)
    - Load Port Door tilt
  - Latch Key Pull-in Allowance >= door seal compression + FOUP Frame perpendicularity error (with respect to HDP) + Load Port Door perpendicularity error (with respect to HDP).
  - When Latch Key turns to close, the FOUP Door position may change if the FOUP Door restraint force is insufficient.
- **Background:**
  - Although, the Load Port tries to return the FOUP Door back to the position where it was, there is a possibility of some miss-alignment due to the parallelism error of the FOUP Door surface to FDP, the FOUP Door deformation, etc.
  - This miss-alignment may cause latch engagement motion error if there is no sufficient allowance in Latch Key mechanism.
- **Approach:**
  - To ensure proper engagement of the door latch mechanism under worst case conditions (such as skewness, warp, misalignment, etc.), the system should be designed, for example, with sufficient cushioning such that it allows for the maximum misalignment between the FOUP Door and frame (Section 6.4.2) and the Load Port (as defined in SEMI E62).
- **Note:**
  - This recommendation may not apply in the case that a Load Port has sufficient flexibility to insert door into a pod with poor perpendicularity.
  - This is an alert to suppliers.



Gap between FOUP and Load Port Frames

4. Gap between FOUP and Load Port Frames

FOUP: FOUP Frame to Load Port Frame Gap/Contact

- **Related USRD:**
  - 4. Gap between FOUP and Load Port Frames
- **Requirement:**
  - The FOUP Frame surface (y52 plane) should be in a 1mm thick volume.
- **Related Standards:**
  - E47.1: y52, y33
  - E62: y33
- **Impact to Standards:**
  - Modification of E47.1: y52
  - NA SG believes that this issue is sufficiently covered by E47.1 6.4.2.
- **Application Note:**
  - See “Gap Model by Current Standards” and “An Example of Gap Model”.
- **Background:**
  - The FOUP Frame and the Load Port Frame better not contact.
  - If they contact, the Wafer Plane should be kept within appropriate accuracy under the deformation due to the contact force. No particle generation should result due to FOUP and Load Port Frame contact.
- **Approach:**
- **Note:**
  - This is a reminder of reexamination of the gap.
  - This gap has to be analyzed for the clarity of 1mm budget in addition to y42.

E47.1:Added to text

FOUP: Inert Gas Application

- **Related USRD:**
  - 4. Gap between FOUP and Load Port Frames
- **Requirement:**
  - The FOUP Frame (body) should be airtight in order to seal inert gas pressure.
  - The Load Port may use a contact seal in the Seal Zone.
  - The Load Port may have to clamp the FOUP Frame to get enough seal capability.
- **Related Standards:**
  - E62-y33, E47.1-y33
- **Impact to Standards:**
  - Need standard modification of the FOUP to be compliant with Frame Clamp.
  - Need addition of clamping exclusion zones in E47.1, and an Application Note discussing airtightness and purging. It can be a concern that clamping may cause the FOUP and the FOUP Door positions to change.
- **Application Note:**
  - The Load Port should be carefully designed not to deform the FOUP nor change the wafer plane.
- **Background:**
  - Inert gas purge of wafer transportation area may be required for heat process equipment to prevent any unexpected oxidization.
  - In order to reduce equipment footprint and cost, the FOUP should be a part of the environmental seal.
- **Approach:**
- **Note:**

E47.1:Added to Front Clamping Feature Z66,67,68,69,x62,y61,

Latch Key Operation

USRD: 3. Repeatability of FOUP Door Position

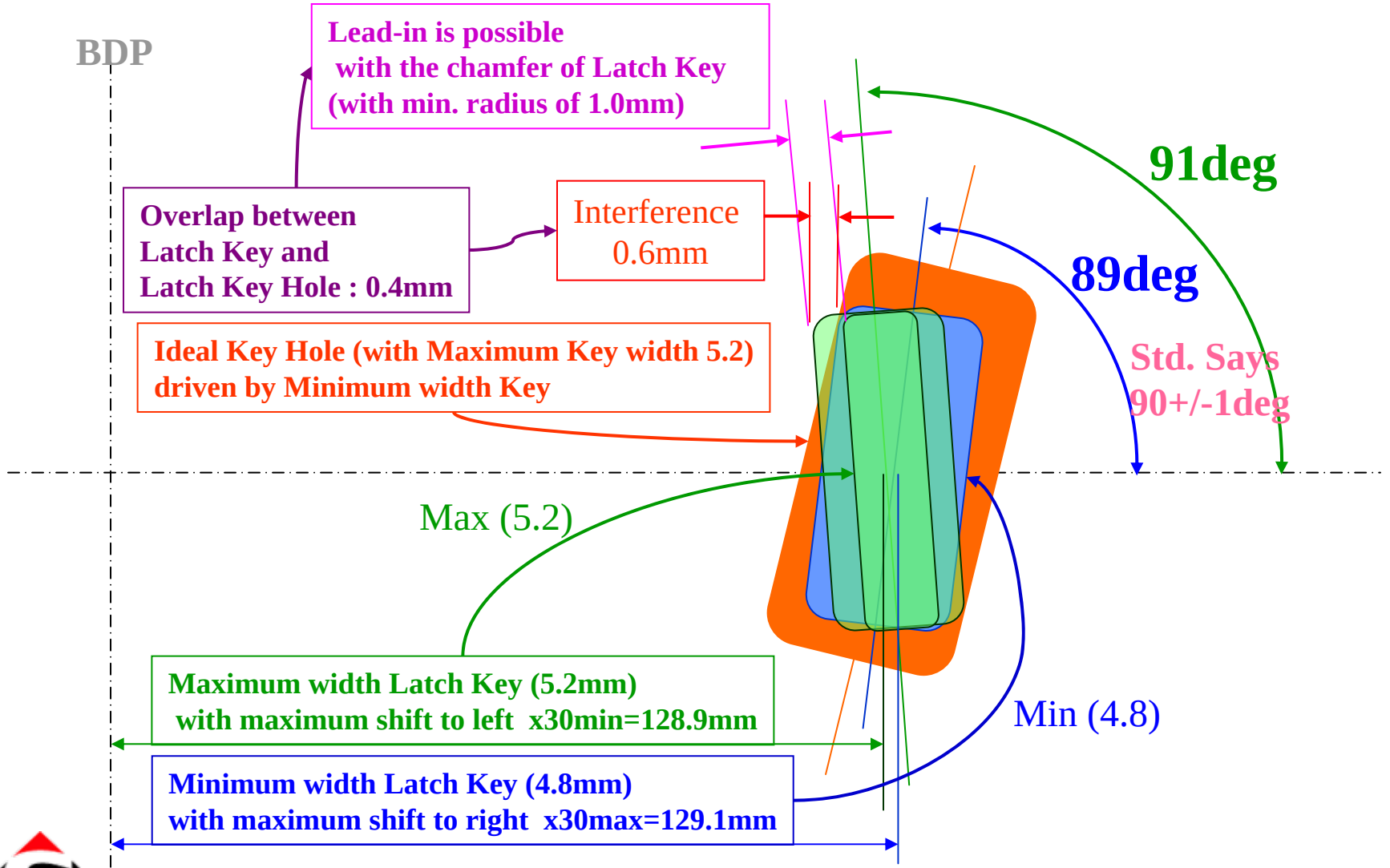
USRD: 6. Study Requirement

E62&47.1:Added to Text & application note

System: Latch Key and Latch Key Hole Alignment and Lead-in

- **Related USRD:**
  - 3. Repeatability of FOUP Door Position
  - 6. Study Requirement
- **Requirement:**
  - This alignment/lead-in method should absorb the FOUP tolerance and the Load Port tolerance defined in E62.
  - Alignment:
    - Latch Key Hole and Latch Key should mate themselves under the condition that the Latch Key Hole to Latch Key alignment is not done by Registration Pins.
    - Latch Key insertion should not be used to position the FOUP Door.
  - Rotation angle:
    - Latch Key rotation should be done properly within Latch Key rotation tolerance defined in E62.
    - Latch Key Hole should hold the rotated angle after Latch Key retraction.
- **Related Standards:**
  - E47.1
  - E62-x30,x36,z30,r36
- **Impact to Standards:**
  - It is recommended to add an application note in E47.1 and create a page which combines all relevant recommendations such as lead-in for Latch Keys Holes, etc. in the SEMI Guide.
- **Application Note:**
  - FOUP suppliers should consider their FOUP tolerance in designing Latch Key Holes.
  - Since the Load Port Door may be displaced as Latch Key engagement proceeds, the Load Port and FOUP Door positions will move after the FOUP Door is opened because of the stress release. Latch Key insertion is preferred to be done with a force that does not cause Load Port Door displacement.
  - Explanation is necessary for FOUPs to compensate for Load Port error in addition to FOUP error.
- **Background:**
  - Since Registration Pins will not be used for lead-in to position door, it is imperative to ensure Latch Keys enter Latch Key Holes.
  - Latch Key may hit Latch Key Hole in case the FOUP Latch Key Hole does not sufficiently return toward center due to a gap between the Latch Key and the Latch Key Hole. See figure.
- **Approach:**
- **Note:**
  - This recommendation does not intend to address the Latch Key lead-in function that realigns the FOUP Door in any way. Rather, it intends to allow reliable Latch Key insertion with FOUP Door position error in the FOUP Frame.

Relation between Latch Key and Ideal Latch Key Hole



Load Port: Latch Key and Latch Key Hole Alignment and Lead-in

- **Related USRD:**
  - 3. Repeatability of FOUP Door Position
  - 6. Study Requirement
- **Requirement:**
  - Compliance with SEMI E62
- **Related Standards:**
  - E62 (r41)
  - E47.1
- **Impact to Standards:**
  - None.
  - Common non-compliances and reinforcement messages may be collected as a section in some SEMI Guide document or the like.
- **Application Note:**
  - Since the Load Port Door may be displaced as the Latch Key engagement proceeds, the Load Port and FOUP Door positions will move after the FOUP Door is opened because of stress release. Latch Key insertion is preferred to be done with a force that does not cause Load Port Door displacement.
- **Background:**
  - Chamfer of Latch Key for lead-in is enough to absorb following error
    - Load Port tolerance
- **Approach:**
- **Note:**
  - Important Reminder

E62:Added to application note

E47.1:Added to application note

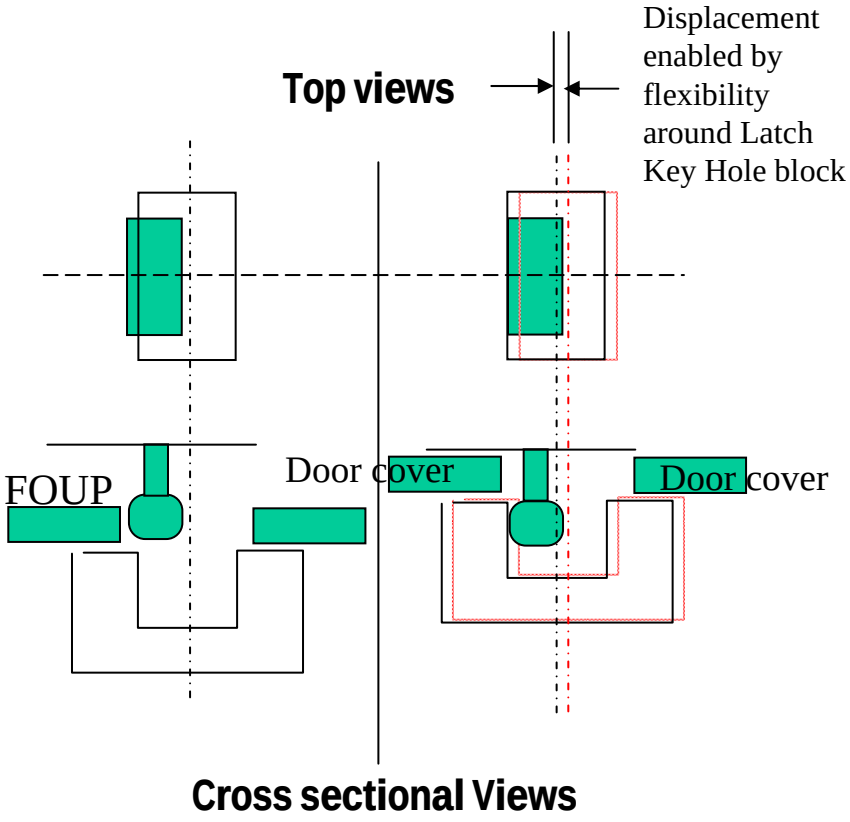
FOUP: Latch Key and Latch Key Hole Alignment and Lead-in

- **Related USRD:**
  - 3. Repeatability of FOUP Door Position
  - 6. Study Requirement
- **Requirement:**
  - The FOUP should have a lead-in mechanism on its Latch Key Holes. This lead-in mechanism should compensate for the FOUP's Latch Key Hole location error and mate with E62. (See previous page)
  - The FOUP is assumed to be able to hold the driven angle of Latch Key Hole by itself as it is driven to the close angle position after Latch Key is retracted.
  - It is recommended to add an application note in E47.1 and to create a page that combines all relevant recommendations such as lead-in for Latch Keys Holes, etc. in a SEMI Guide.
- **Related Standards:**
  - E62, (E47.1)
- **Impact to Standards:**
  - None.
- **Application Note:**
  - The lead-in mechanism should not require large lead-in force, so that docking motion is not disturbed.
  - Since the Load Port Door may be displaced as Latch Key engagement proceeds, the Load Port and FOUP Door positions will move after the FOUP Door is opened because of stress release. Latch Key insertion is preferred to be done with a force that does not cause Load Port Door displacement.
- **Background:**
  - The Latch Key of the Load Port should be SEMI E62 compliant.
  - The Load Port cannot use Registration Pins for lead-in. This function is intended to be used not for FOUP Door positioning to the Load Port upon Latch Key insertion but for Latch Key insertion under Latch Key Hole location error.
- **Approach:**
  - The FOUP should have reasonable Latch Key lead-in based on its respective overall tolerances.
- **Note:**
  - The following two slides discuss Latch Key chamfer and Latch Key Hole alignment.

FOUP: Latch Key and Latch Key Hole Alignment and Lead-in (Continued)

- **Note:**
  - **Relationship between Latch Key and Latch Key Chamfer**
  - **Latch Key Chamfer (E62:r41=1.5+/-0.5mm) should be designed within Standards limit to provide lead-in capability so that it can absorb the Latch Key location difference against an ideally situated Latch Key Hole.**
  - **The insertion sequence is as in the figures on the right.**
    - **The Latch Key Hole is at the ideal position.**
    - **The Latch Key axis is off the Latch Key Hole axis.**
    - **The Latch Key goes into the Latch Key Hole as the Load Port moves toward the FOUP**
    - **The Latch Key hits its edge on the edge of the Latch Key Hole.**
    - **The Latch Key chamfer works as it leads the Latch Key into the Latch Key Hole**
    - **The Latch Key is fully and correctly inserted into the Latch Key Hole.**
    - **This action never takes place unless Latch Key Hole block has flexibility around it.**

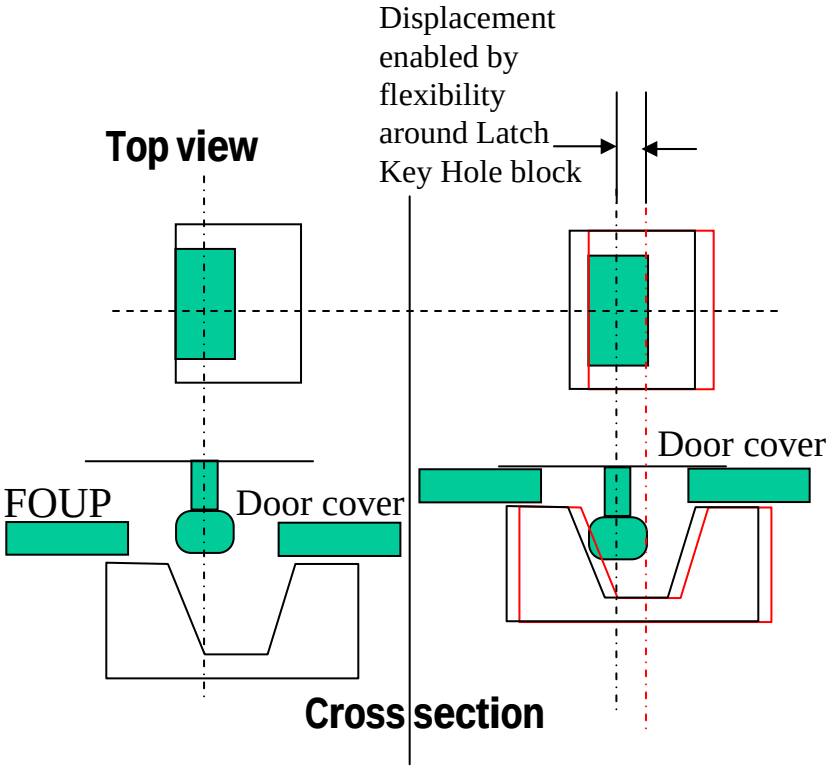
E47.1:Added to application note



FOUP: Latch Key and Latch Key Hole Alignment and Lead-in (Continued)

E47.1:Added to application note

- **Note:**
  - Relationship between Latch Key Hole and Latch Key Hole Chamfer.
  - Latch Key Hole Chamfer should be designed to provide lead-in capability so that it can absorb the Latch Key Hole location difference against the ideally situated Latch Key made to the standard.
  - The insertion sequence is as in the figures on the right.
    - The Latch Key is at the ideal position.
    - The Latch Key Hole axis is off the Latch Key axis.
    - The Latch Key goes into Latch Key Hole as the Load Port moves toward the FOUP
    - The Latch Key hits its edge on the edge of Latch Key Hole.
    - The Latch Key Hole chamfer works as it leads the Latch Key into the Latch Key Hole
    - The Latch Key is fully and correctly inserted into the Latch Key Hole.
    - This action never takes place unless the Latch Key Hole block has flexibility around it.
    - For the worst case where both of the locations are maximally apart, the lead-in capabilities still assure proper operation.



FOUP: Holding of Latch Key Hole Rotation Angle During Closed

- **Related USRD:**
  - Study Requirement
- **Requirement:**
  - The FOUP should hold the rotation angle of the Latch Key Hole within a determined angle while the FOUP Door is closed.
  - This angle should be proposed by TF.
- **Related Standards:**
  - E62: Ψ (Phi)
- **Impact to Standards:**
  - No conflict.
  - Add holding tolerance to E47.1.
  - It is recommended to add an application note in E47.1 and to create a page that combines all relevant recommendations relevant to Latch Keys or Latch Key Holes, etc. in a SEMI Guide.
- **Application Note:**

- **Background:**
  - Without an angle holding function, the Latch Key Holes may rotate after Latch Key release. This may cause Latch Key to Latch Key Hole miss-alignment in the next docking sequence.
- **Approach:**
- **Note:**

Not balloted yet

FOUP: FOUP should Pull-in Latch Key Hole Angle into Origin from Nearly-Closed Position

- **Related USRD:**
  - Study Requirement
- **Requirement:**
  - The FOUP should actively return the Latch Key Hole to its original position from a nearly closed position
- **Related Standards:**
  - E62, f30
- **Impact to Standards:**
  - No change, but potential addition.
    - E62 and similar dimension for E47.1
- **Application Note:**
  - Use a hard Latch Key Hole stop in addition to a wider active pull-in allowance
    - The pull-in allowance angle > (Latch Key-to-Latch Key Hole clearance 0.5mm (r36=6.75mm)) + Latch Key angular error 1eg = 5.2deg.
  - The torque required to engage the hard stop should not exceed E62-f30.

- **Background:**
  - Although the Load Port may drive the Latch Key back to a center origin, the FOUP Latch Key Hole may have an angular offset due to excessive clearance, etc. which may cause a mismatch between this FOUP and the Latch Key of the next Load Port.
  - Refer to drawing on page 50 (FOUP: Need Latch Key Hole flexibility)
- **Approach:**
- **Note:**
  - An overdrive mechanism for the Latch Key on the Load Port side may be a solution.
  - In the FOUP cleaner case, Latch Key Hole angular position should be maintained.
  - The application of this recommendation may be complex, and therefore cleanability and dryability should be carefully considered.

E47.1:Added to application note

Load Port: Increase Lead-in Capability of Latch Key

- **Related USRD:**
  - <Study requirement> Latch Key Operation
- **Requirement:**
  - Apply steeper lead-in feature to Latch Key top.
- **Related Standards:**
  - E62-y36
- **Impact to Standards:**
  - E62 Latch Key shape change
- **Application Note:**

- **Background:**
  - Although the Load Port may drive the Latch Key back to a center origin, the Latch Key Hole may have an angular offset due to excessive clearance, etc. which may cause a mismatch between this FOUP and the Latch Key of the next Load Port.
- **Approach:**
  - A steeper Latch Key shape may help lead-in as well as centering .
  - An overdrive mechanism for the Latch Key on the Load Port side may be a solution, but it increases complexity and should be avoided if possible.
- **Note:**
  - Optimization of the key shape is needed.

Not balloted yet

Adopt only in case other recommendations are not enough to solve the problem

Load Port: Over drive function of Latch Key

- **Related USRD:**
  - <Study requirement> Latch Key Operation
- **Requirement:**
  - The Load Port should drive the Latch Key beyond 90 degrees, and then return the key to the original center position.
- **Related Standards:**
  - E62-Y
- **Impact to Standards:**
  - Add definition of overdrive angle.
- **Application Note:**
  - Overdrive angle (radian) = Latch Key and Latch Key Hole clearance ¸ r36 (E62)
- **Background:**
  - Although the Load Port may drive the Latch Key back to center origin, the Latch Key Hole may have an angular offset due to excessive clearance, etc. which may cause a mismatch between this FOUP and the Latch Key of the next Load Port.
  - It may be difficult to implement a hard stop mechanism in the FOUP Door.
- **Approach:**
- **Note:**
  - It is difficult for equipment to implement this capability

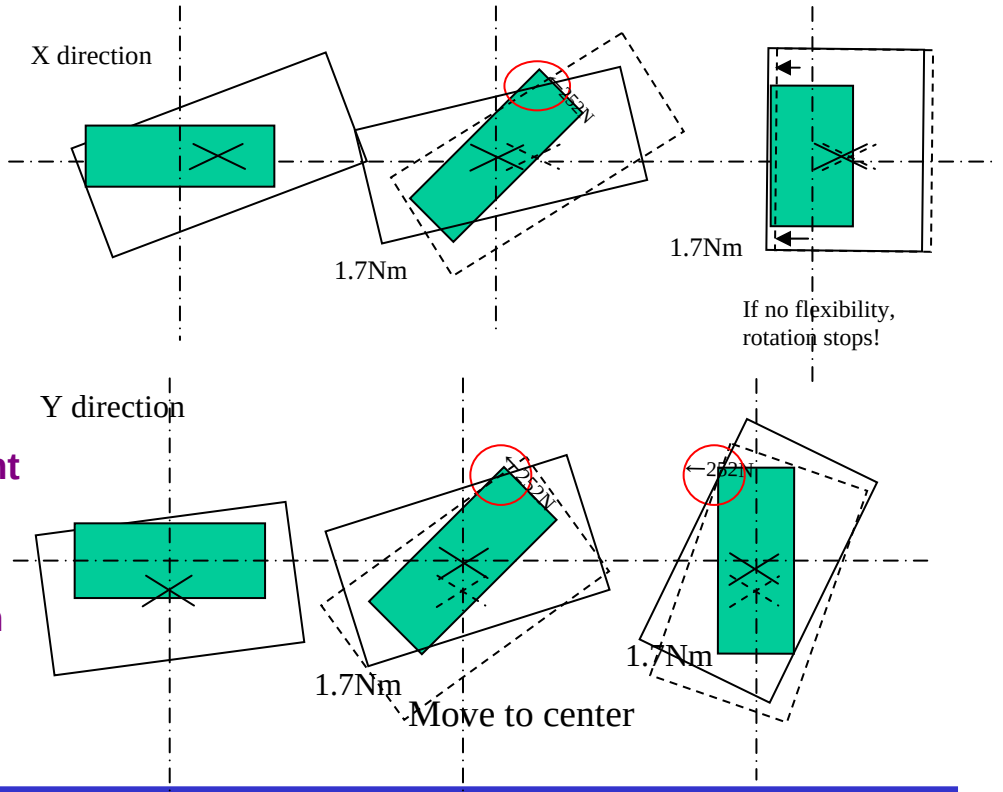
Not balloted yet

Adopt only in case other recommendations are not enough to solve the problem

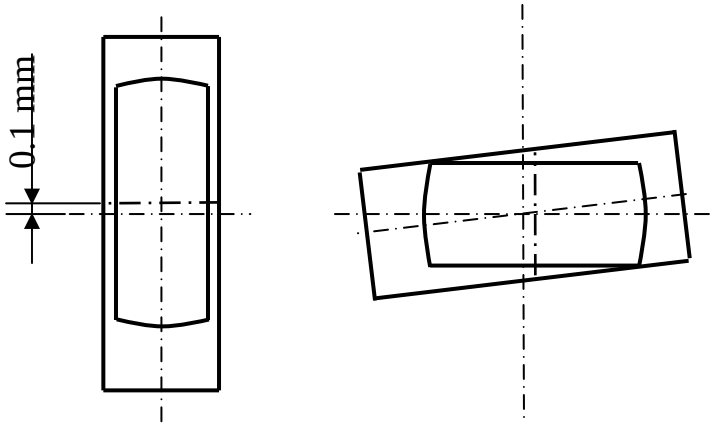
FOUP:Need Latch Key Hole Flexibility

E47.1:Added to application note

- **Related USRD:**
  - 3. Repeatability of FOUP Door Position
  - 6. Study Requirement
- **Requirement:**
  - The FOUP should have a capability to accept a discrepancy between the Latch Key and the Latch Key Hole axes.
  - The Latch Key Hole should have flexibility around its original position.
- **Related Standards:**
  - E47.1
- **Impact to Standards:**
  - None.
- **Application Note:**
  - If Latch Key Hole has no flexibility, the Latch Key axis can not rotate.
- **Background:**
  - There is no function assured by the current standards of absorbing the location difference between the Latch Key center and the Latch Key Hole center axes.
  - If the difference is not absorbed, the Latch key cannot drive the Latch Key Hole as shown in the figures.
  - The flexibility is to be determined by TF.
  - Rotation center of Latch Key Hole goes to Latch Key rotation center by thrust force as much as the flexibility allows.
- **Approach:**
- **Note:**
  - See next foil for more detail



FOUP: Need Latch Key Hole Flexibility (continued)

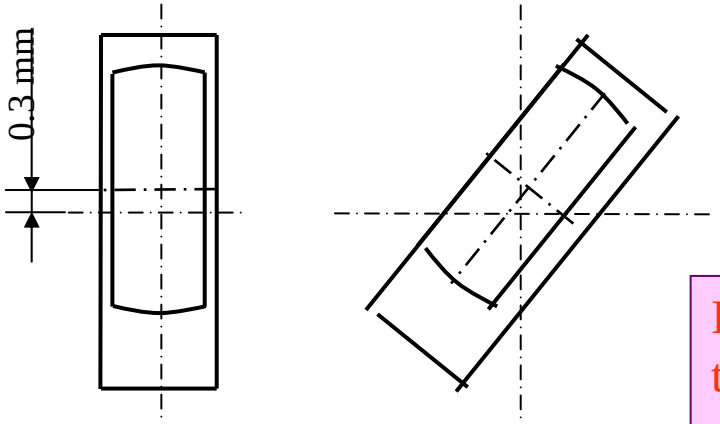


Latch Key rotates ;
90degree

Latch Key Hole rotates ;
89.07degree

E47.1:Added to application note

Latch Key can rotate till 90degree



Latch Key rotates ;
42degree

Latch Key Hole rotates ;
42degree

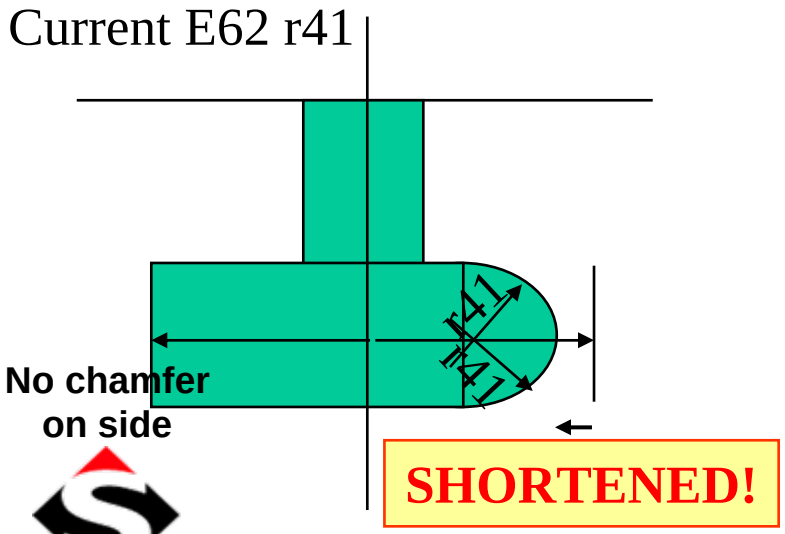
If only one side of Latch Key pushes the inside of Latch Key Hole, Latch Key can not rotate further.

Latch Key rotation stops before 90deg.

Load Port: Clarify Latch Key and Latch Key Hole Alignment and Lead-in

E62: r41 was changed 1.5+-0.5mm to 1.5+/- 0.2mm

- Related USRD:
  - 3. Repeatability of FOUP Door Position
  - 6. Study Requirement
- Requirement:
  - TF to change r41 value in SEMI E62 .
- Related Standards:
  - E62 (r41)
- Impact to Standards:
  - The r41 chamfer to become smaller.
  - 1.5 +- 0.5 mm to 1.5 +- 0.2mm



- Application Note:
- Background:
  - The blend radius defined in the current standard allows for excessive rounding of the Latch Key resulting in the Latch Key becoming shorter than desired.
  - The chamfer of the Latch Key for lead-in is enough to accommodate the following tolerance
    - Latch Key location variation relative to FIMS
- Approach:
  - E62 TF to redefine appropriate value for r41.
- Note:
  - Although the thickness of Latch Key is 3.4mm min., as r41 can be anything between 1.0 to 2.0mm, the length of Latch Key will be shortened in the case of r41=2.0mm.
  - The shortened Latch Key will have inferior functionality than ones of ordinary length.
  - E62 TF is to work on this issue to correct the blend radius tolerance.

Frame/Seal-Zone Clearance

USRD: 2: FOUP and Load Port Door/Frame Size Relation

FOUP: Clearance between FOUP Frame and FOUP Door

- **Related USRD:**
  - 2: FOUP and Load Port Door/Frame Size Relation
- **Requirement:**
  - The outline of the FOUP Door should be smaller than the associated edge of the Seal Zones.
  - The outline of the FOUP Frame should be larger than the associated edge of the Seal Zones.
- **Related Standards:**
  - E62
  - E47.1
- **Impact to Standards:**
  - It is recommended submitting a line item ballot to E62 to make the Load Port Door opening no smaller than the inner edge of the frame seal zone defined by x34, z34, and r34.
- **Application Note:**
- **Background:**
  - There is no definition on seal zone overlap between the FOUP and the Load Port (at the FIMS interface).
  - The 1.5mm (minimum) clearance between the Frame Seal Zone and the Door Seal Zone is not sufficient (E62).
  - A design that allows the largest possible gap between the FOUP Frame and the FOUP Door is preferred to avoid potential particle generation.
- **Approach:**
- **Note:**
  - See the following figures.

E47.1: Added to text at section 5.6

Load Port: Clearance between Load Port Frame and FIMS Door

- Related USRD:
  - 2: FOUP and Load Port Door/Frame Size Relation
- Requirement:
  - The outline of the Load Port Frame facing the FOUP Frame and the Load Port Door facing the FOUP Door should be equal to the respective associated Seal Zones.
- Related Standards:
  - E62: x33, x34, z33, z34
- Impact to Standards:
  - No conflict. (Currently no definition about the Load Port Door and frame)
  - Add outline dimensions of the Load Port Frame and the Load Port Door in E62.
- Application Note:

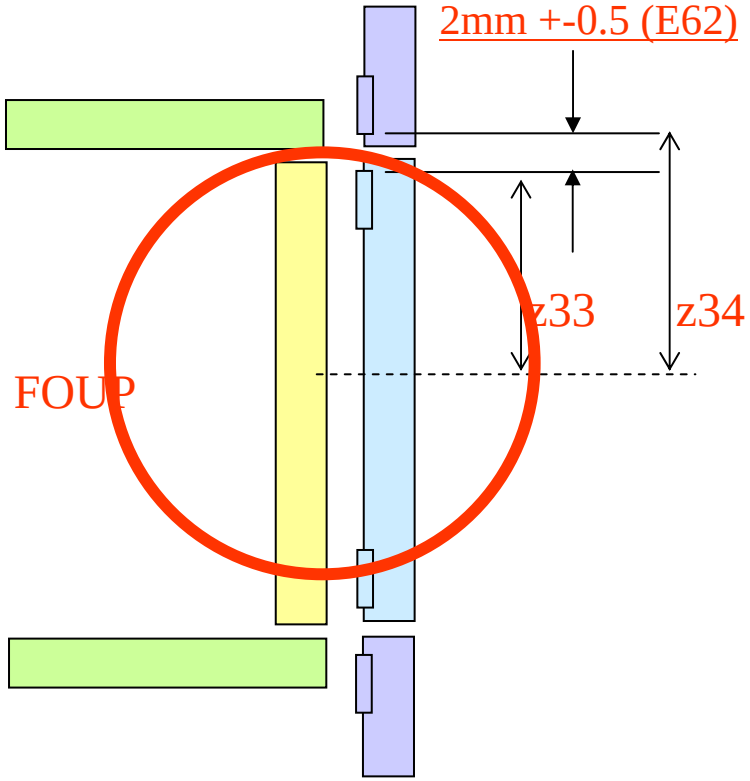
E62:Added to Text

- Background:
  - There is no definition on seal zone overlap between the FOUP and the Load Port (at the FIMS interface). Dimensions z34, y34, and r34 define the INSIDE EDGE of the FRAME SEAL ZONE, but NOT the opening size. This is the most frequently heard misunderstanding, and this is missing from current Standards.
  - The 1.5mm (minimum) clearance between Frame Seal Zone and Door Seal Zone is not sufficient (E62).
  - A design that allows the largest possible gap between the FOUP Frame and the FOUP Door is preferred to avoid potential particle generation.
- Approach:
- Note:
  - This recommendation is expecting “FOUP: Clearance between FOUP Frame and FOUP Door” at the same time.
  - Need a clear gap model studied by TF.
  - See the following notes.

Load Port: Clearance between Load Port Frame and FIMS Door (continued)

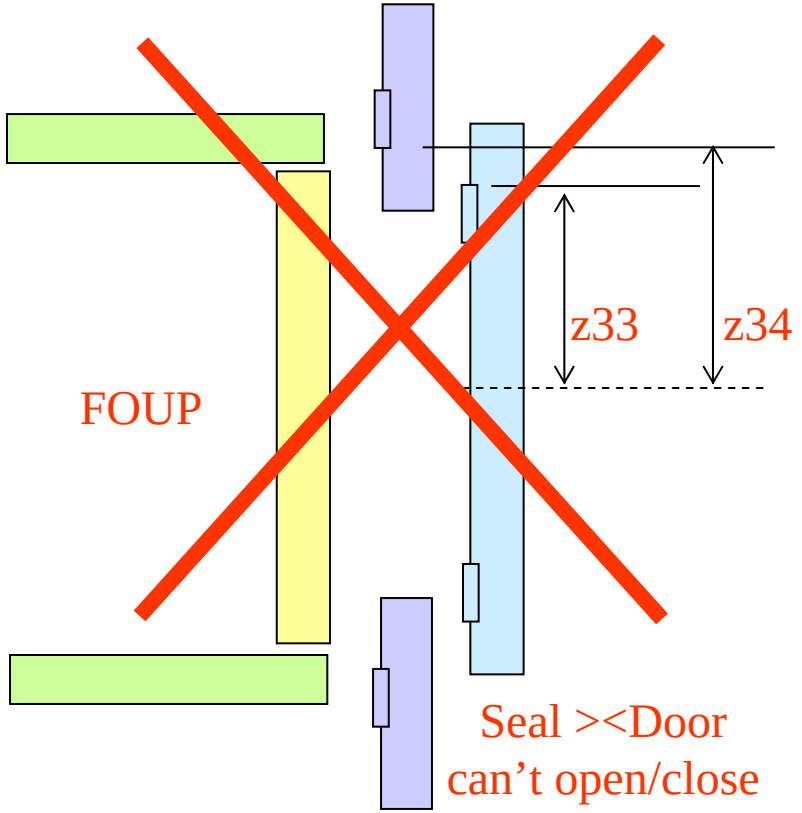
E62:Added to Text

- Note:
  - Current standard definition



Good

- Note:
  - Current standard may lead to this;
  - Load Port Door can never go through Load Port Frame.

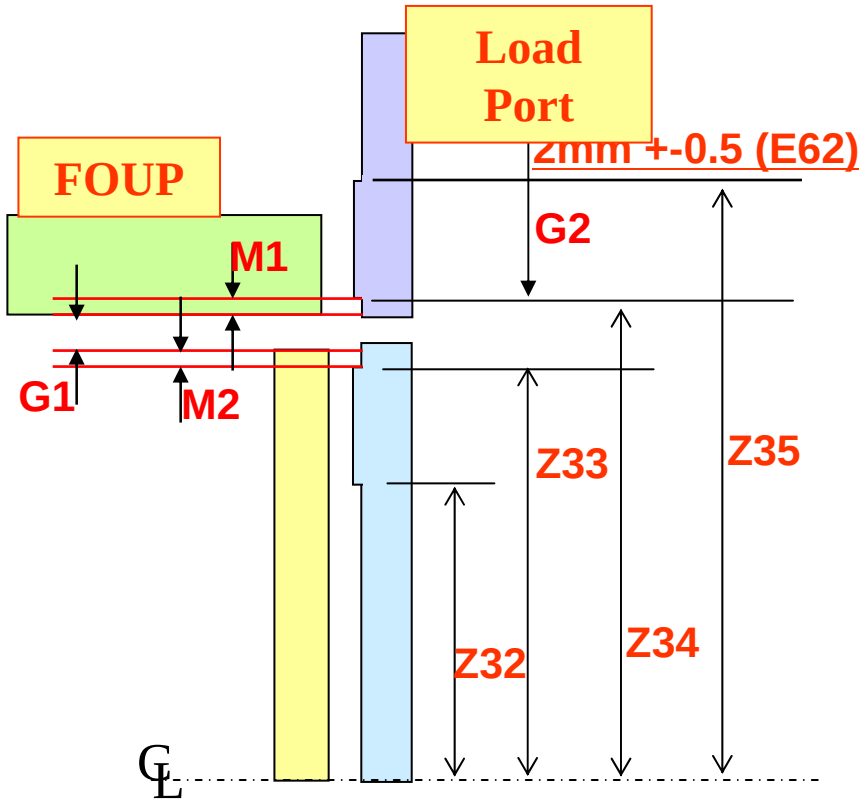


Bad

Load Port: Clearance between Load Port Frame and FIMS Door (continued)

E62:Added to Text

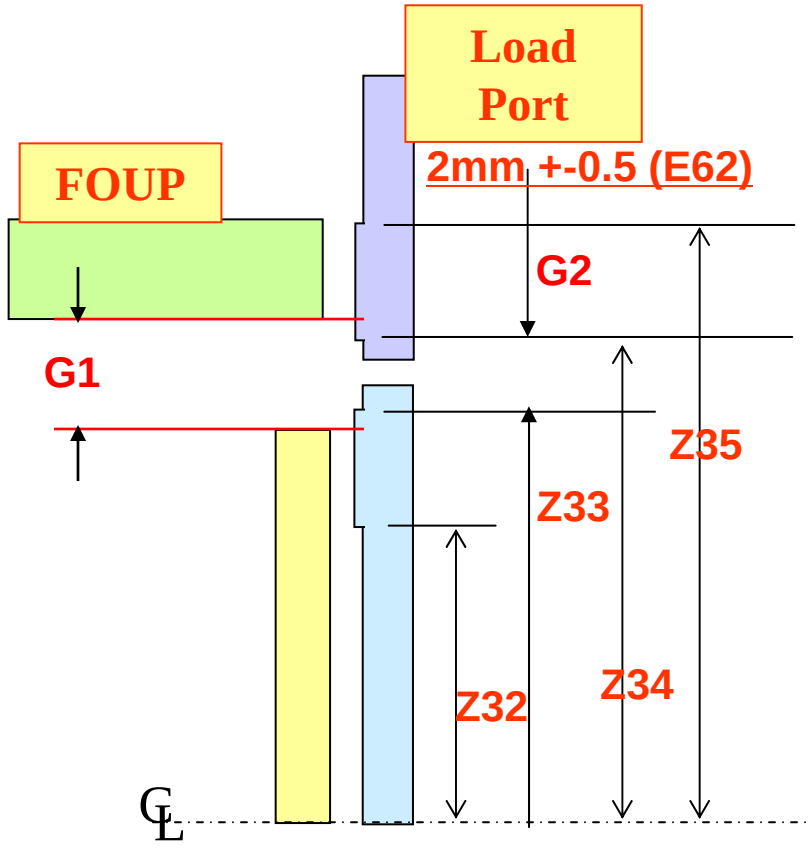
- **Note:**
  - The Load Port Seal Zone is wide enough, but FOUP suppliers do not know if the Load Port uses the outermost location for sealing.
  - FOUP suppliers have to provide sufficient area to mate with the outer part of the Load Port Seal Zone (at z33).
  - But this FOUP design eats up the gap between the FOUP Door and the FOUP Frame (G1).
  - The gap between two Seal Zones on the Load Port (G2) is 1.5mm in the worst case according to E62.
  - If the FOUP is designed to give 0.5mm of margin (M1& M2) to the mating area along z33 to ensure the seal zone mating, the gap between the FOUP Frame and Door (G1) will be eaten up to be only 0.5mm.
  - Such small gap can cause a particle generation problem and not at all recommended.



Load Port: Clearance between Load Port Frame and Load Port Door (continued)

E62:Added to Text

- The problem was explained in the previous page.
- The possible remedies are following;
  - LP suppliers provide continuous sealing zone between z32 and z33 on the Load Port Door so that the FOUP Door can be small than z33.
    - AND
  - At the same time LP suppliers provide continuous sealing zone between z34 and z35 on the Load Port Frame so that the FOUP Frame can be larger than z34.
- OR
  - LP suppliers only use the most inner edge of the seal zone on the Load Port Door.
  - LP suppliers only use the most outer edge of the seal zone on the Load Port Frame.
    - AND
  - FOUP suppliers should design FOUP Doors to leave largest possible Gap (G1).

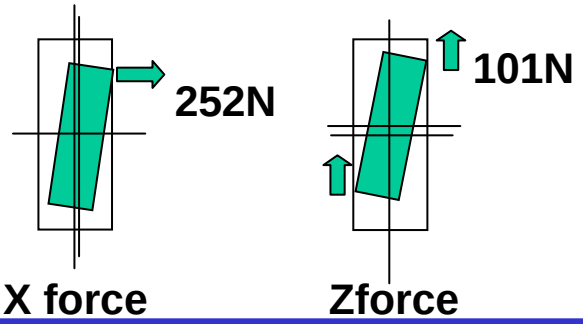


Force

FOUP: FOUP to Reduce Latch Key Hole Torque

E47.1:Added Discourage excessive latch key torque

- **Related USRD:**
  - 3. Repeatability of FOUP Door Position
- **Requirement:**
  - The FOUP to reduce required Latch Key Hole torque
  - Drive torque of present Load Ports should remain as they are.
- **Related Standards:**
  - E62-f30,r36
- **Impact to Standards:**
  - These values are to be defined in TF.
    - P.61 - P.65 are all related and need some coordination.
- **Application Note:**
  - The FOUP should not require more torque for rotation of the Latch Key such that it will produce movement of the FOUP Door in x and z directions.
    - If FOUP Door holding force = 50N, then Latch Key torque = 50N x (key radius of 6.75mm) = 0.340Nm
- **Background:**
  - X, Z direction forces caused by a rotation center offset between the Latch Key and the Latch Key Hole may displace the FOUP Door which is caught by the Load Port Door, and may result in particle generation.
    - X force: Key Torque 1.7Nm / Key radius 6.75mm = 252N
    - Z force: X force * friction factor (0.4?) = 101N
- **Approach:**
  - A universal joint may be a solution.
  - Flexibility in the Latch Key Hole can reduce this displacement force.
- **Note:**
  - Need more study.



FOUP: FOUP should accept Latch Key under E62 Force Specs

- **Related USRD:**
  - <Study requirement> Latch Key Operation
- **Requirement:**
  - The Latch key Hole should be aligned by itself to Latch Key upon Latch Key insertion by a lateral force component induced by the Latch Key insertion force as the Latch Key chamfer surface presses down the Latch Key Hole taper surface.
    - Define forces required for Latch Key Hole "flexibility" action
- **Related Standards:**
  - E62: f30
    - E62 f30 Latch Key Torque =< 1.7Nm
- **Impact to Standards:**
  - It is recommended SEMI TF will work on this issue.

Not balloted yet

- **Application Note:**
  - Example of induced lateral force = (Docking Force 9N) * (lead-in efficiency 0.5) = 4.5 N
    - Taper angle of 60deg is assumed.
  - This force may be the force induced by f33 upon Latch Key insertion.
  - If the Latch Key Hole is to rotate to align to the Latch Key, the available torque = (Contact point of Latch Key Hole r=6.75mm) * (lateral force) = 6.75*4.5=0.03 Nm
  - The FOUP is supposed to be designed to have available an effective flexibility action of the Latch Key Hole against this small torque.
- **Background:**
  - The Latch Key Holes of the FOUP have an angle tolerance due to clearance etc. while the Latch Key rotates within +-1 degree.
  - The FOUP should have a lead-in capability to absorb this angle error under the force definitions in E62.
- **Approach:**
  - Adding a steeper lead-in shape on the Latch Key may cause insufficient rotation torque.
- **Note:**

Load Port: Minimum Docking Force Definition

- **Related USRD:**
  - 3. Repeatability of FOUP Door Position
- **Requirement:**
  - The Load Port should have sufficient docking force to enable insertion.
- **Related Standards:**
  - E62-f33<9N、f34<9N
- **Impact to Standards:**
  - Add a definition of minimum docking force to E62.
  - It is recommended that “FOUP: FOUP to Reduce Latch Key Hole Torque” to “Load Port: Dock Holding Force should be larger than Door Open/Close Force” are all related and can be addressed by clarification in the respective SEMI Standards.
- **Application Note:**
- **Background:**
  - Friction due to Latch Key lead-in, FOUP Door centering force, etc. may impede docking.
- **Approach:**
- **Note:**
  - Upper limits defined in E62 f33, f34 may be too small.

E62:f34 was changed to more than 9N

f33 was deleted.

Load Port: Minimum Door Closing Force Definition

- **Related USRD:**
  - 3. Repeatability of FOUP Door Position
- **Requirement:**
  - The Load Port should close the FOUP Door with enough force to overcome resistance caused by use of elastomers, retainers, etc. in the FOUP.
  - It is recommended that "FOUP: FOUP to Reduce Latch Key Hole Torque" to "Load Port: Dock Holding Force should be larger than Door Open/Close Force" are all related and can be addressed by clarification in respective SEMI Standards.
- **Related Standards:**
  - E62-f33<9N、f34<9N
- **Impact to Standards:**
  - These dimensions are to be defined in TFs.
- **Application Note:**
- **Background:**
  - If maximum vibration acceleration of 1G is assumed during AMHS handling, each retainer for a wafer should be capable of providing 127g*1G force, and this ends up with 31N for 25 wafers. The closing of the FOUP Door should overcome this force.
- **Approach:**
- **Note:**
  - More study needed.

E62:f34 was changed to more than 9N

f33 was deleted.

Load Port: Dock Holding Force should be larger than Door Open/Close Force

- **Related USRD:**
  - 3. Repeatability of FOUP Door Position
- **Requirement:**
  - Docking force (E62 f33) should be larger than Door closing force (E62 f34)
    - E62 f34 < E62 f33
- **Related Standards:**
  - E62: f33<9N, f34<9N
- **Impact to Standards:**
  - No contradiction to current SEMI Standards.
  - Better to add f34 < f33 in E62
  - P.61 - P.65 are all related and can be addressed by clarification in respective SEMI Standards.
- **Application Note:**

- **Background:**
  - Docking motion may be pushed back by wafer retainer force during FOUP Door closing.
- **Approach:**
- **Note**
  - f34 tends to be larger.
  - Upper limits defined in E62 f33, f34 may be too small.

E62:f34 was changed to more than 9N.

f33 was deleted.

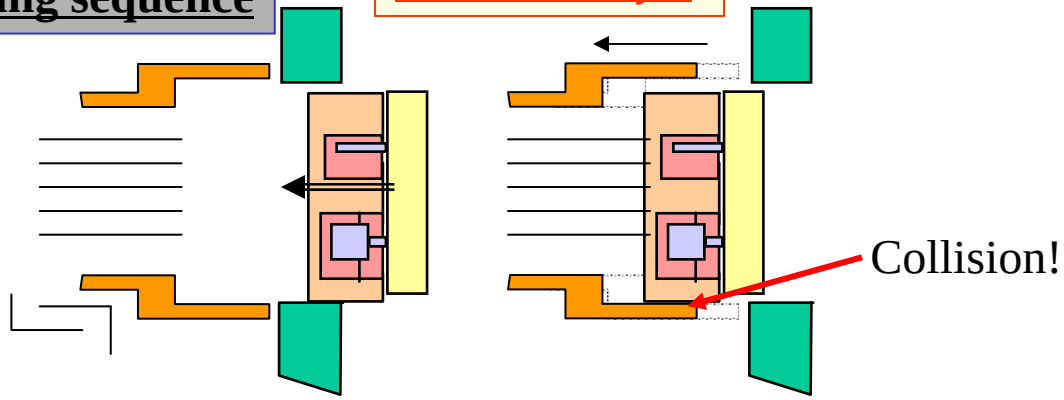
Not balloted yet

FOUP: KC Creeping prevention by f33, f34

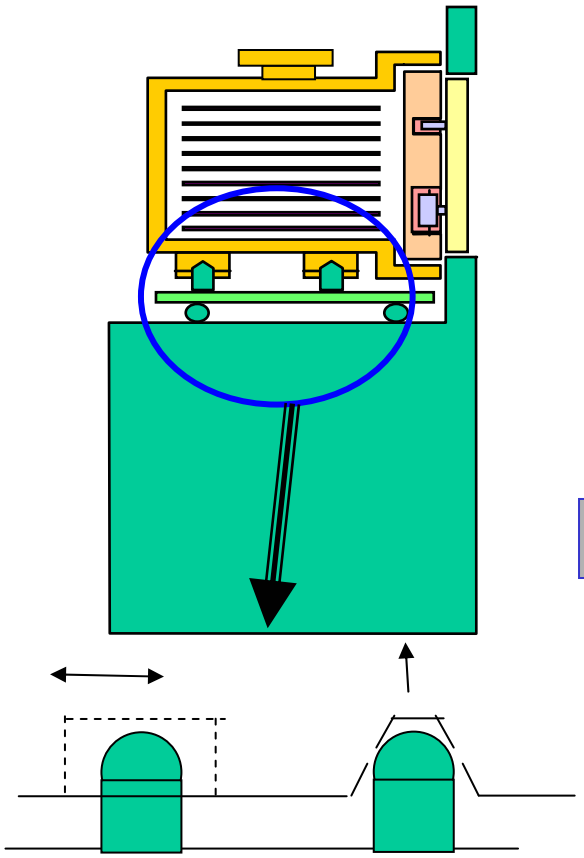
- Related USRD:
  - 3. Repeatability of FOUP Door Position
- Requirement:
  - The FOUP should hold its position against lateral force f33 or f34 so as not to allow the FOUP to creep up along the V-groove surface.
- Related Standards:
  - E57、E47.1
- Impact to Standards:
  - No contradiction.
- Application Note:
  - Reminder: f60 should comply with the standard (175N).
- Background:
  - As the FOUP Door enters the FOUP Frame, the FOUP Door retainers first come in contact with the wafers in the FOUP. The retainers will be pushed back by wafers, or in other words, the FOUP will escape from docking position as the FOUP Door is closed.
  - The FOUP can displace as KC-pins move along the surface of the V-groove wall. The rear KC-pin can move along the direction of its V- groove freely. Furthermore, as the FOUP moves upward, the lower edge of the FOUP Door can collide with the bottom inside of the FOUP Frame.
  - In the FOUP Door opening sequence, when the FOUP Door is opened, suddenly the retainers will push back wafers in the FOUP and cause FOUP displacement from its docked position.
  - This FOUP displacement will push up the FOUP Frame, and induce a lower edge collision of the FOUP Door with the bottom inside of the FOUP Frame.
- Approach:
  - Clamping may prevent the FOUP from creeping.
  - Changing the direction of the V-grooves may be an answer.
  - Combination of grooves as described in E57 appendix Figure 5 may be an answer.
  - This will require more discussion.
- Note:
  - See figures in the following page.

Closing sequence

Not balloted yet



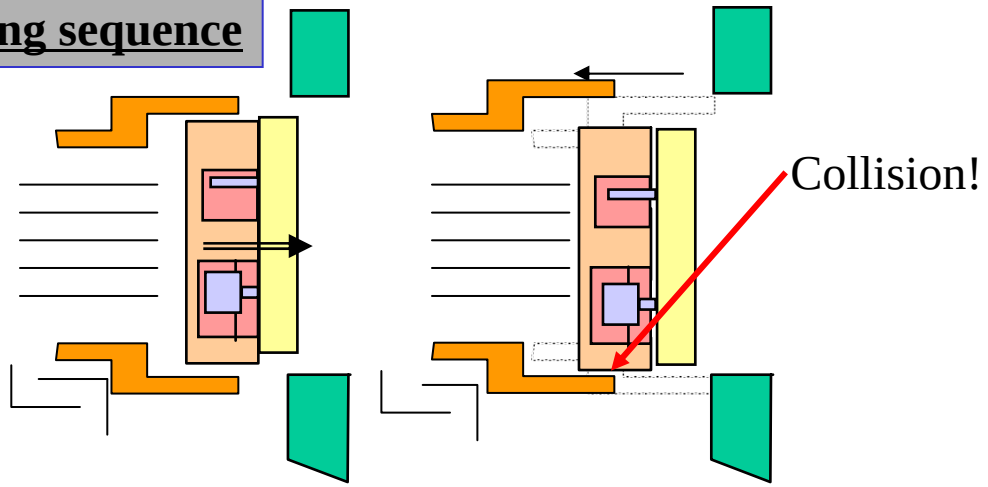
F34 displaces FOUP Shell which creeps up.



No stopping capability!

Creep-up

Opening sequence



F33 displaces FOUP up, and it falls down as FOUP Door being taken out.

Wafer Center

FOUP: Wafer center should not be retained in front of FDP

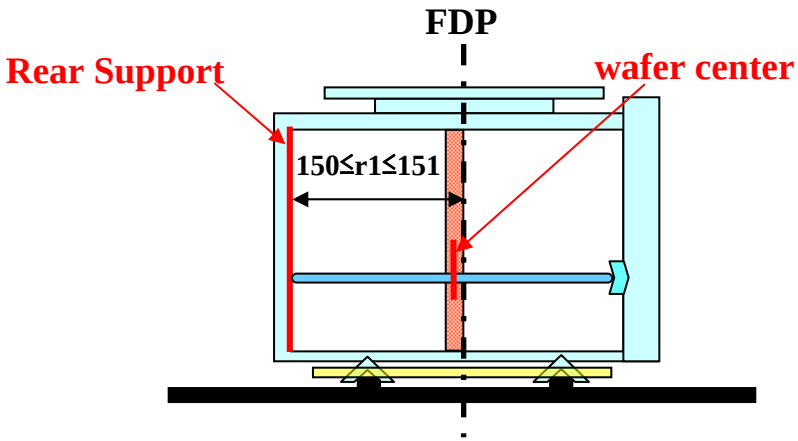
- **Related USRD:**
  - 5. Accuracy of Wafer Location
- **Requirement:**
  - Wafer center position should not exceed FDP towards front door side of FOUP when FOUP retains wafers.
- **Related Standards:**
  - E1.9,E47.1
- **Impact to Standards:**
  - None
- **Application Note:**
  - Measurement Method: Refer to Wafer Center Location, FOUP Measurement Methods in Auxiliary Information: FOUP-Load port Interoperability Implementation Recommendations

- **Background:**
  - r1≤151 is defined wafer pick-up volume and distance between FDP and the rear support.
    - Wafer pick-up volume needs minimum wafer size of 150mm
    - r1 is from minimum 150 to 151 and below 150 is impossible.
  - Robot calibration is usually done with actual FOUP.
    - Wafer edge may hit FOUP at its placement if; robot is adjusted with a FOUP that is designed to retain wafer closer to rear of FOUP, and wafer is placed into a FOUP that is designed to retain wafer closer to front
- **Approach:**
  - FOUP should be designed to retain wafer at a position so that the wafer center do not exceed FDP towards front of FOUP.
  - FOUP door close action pushes the wafer to the retained position of the FOUP by sliding it on the wafer support, if the wafer is placed forward of FDP.

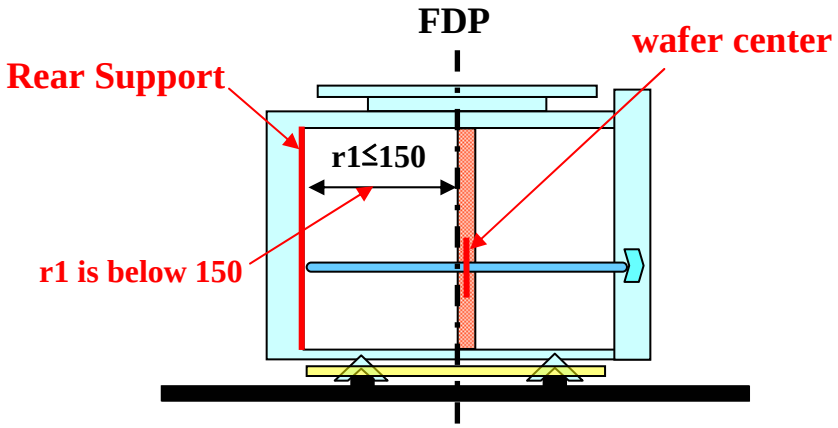
Review of r1≤151 Wafer Pick Up Volume

- wafer center is not retained in front of FDP
- wafer center is retained in front of FDP

OK



NG: violation of r1 definition



- The carrier retains wafer center in front of FDP controls r1 by the position of the rear support. r1 of this carrier becomes below 150. This obviously violate the r1 definition.

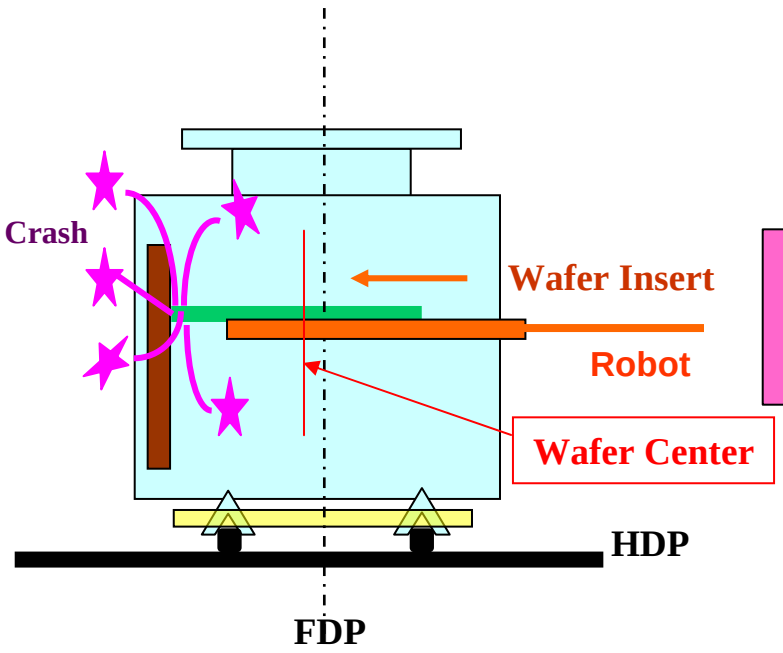
Thus,Wafer Center should not be retained in front of FDP.

Robot: Wafer center should be set down in front of FDP

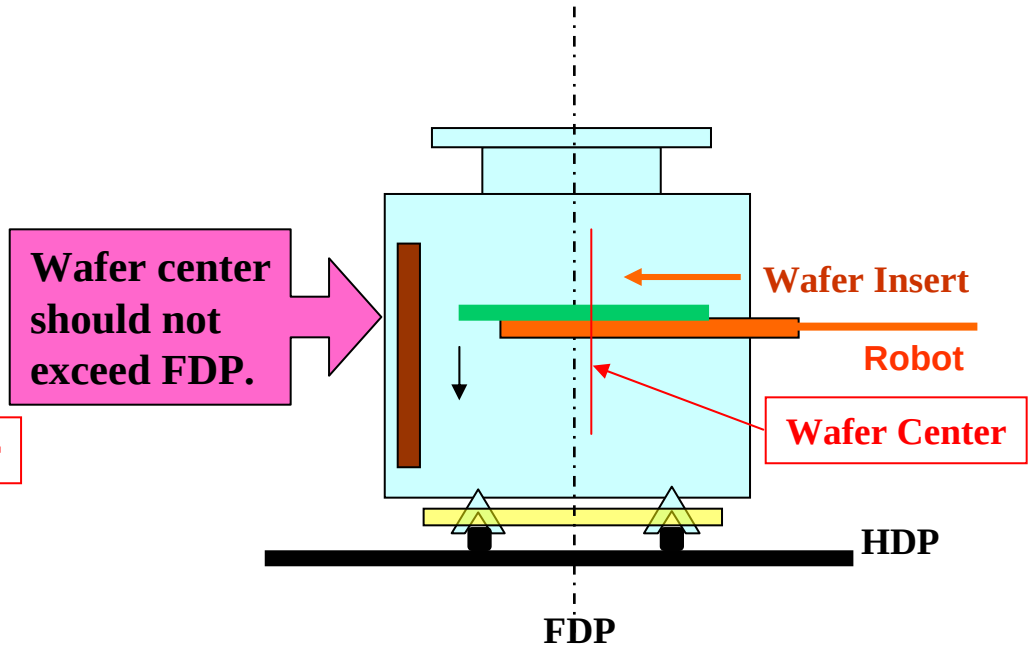
- **Related USRD:**
  - 5. Accuracy of Wafer Location
- **Requirement:**
  - Wafer center position should not exceed FDP towards rear of FOUP when robot places wafer to FOUP.
- **Related Standards:**
  - E1.9,E47.1
- **Impact to Standards:**
  - None.
- **Application Note:**
  - None.

- **Background:**
  - r1≤151 is defined wafer pick-up volume and distance between FDP and the rear support.
    - Wafer pick-up volume needs minimum wafer size of 150mm
    - r1 is from minimum 150 to 151 and below 150 is impossible.
  - Robot calibration is usually done with actual FOUP.
    - Wafer edge may hit FOUP at its placement if; robot is adjusted with a FOUP that is designed to retain wafer closer to rear of FOUP, and wafer is placed into a FOUP that is designed to retain wafer closer to front
- **Approach:**
  - Robot should be calibrated to place wafer at a position so that the wafer center do not exceed FDP towards rear of FOUP.
    - Use of calibration tool is recommended instead of calibrating with actual FOUP.
- **Note:**
  - Particle generation caused by wafer sliding on wafer support is less than that of wafer edge hitting FOUP at its placement.

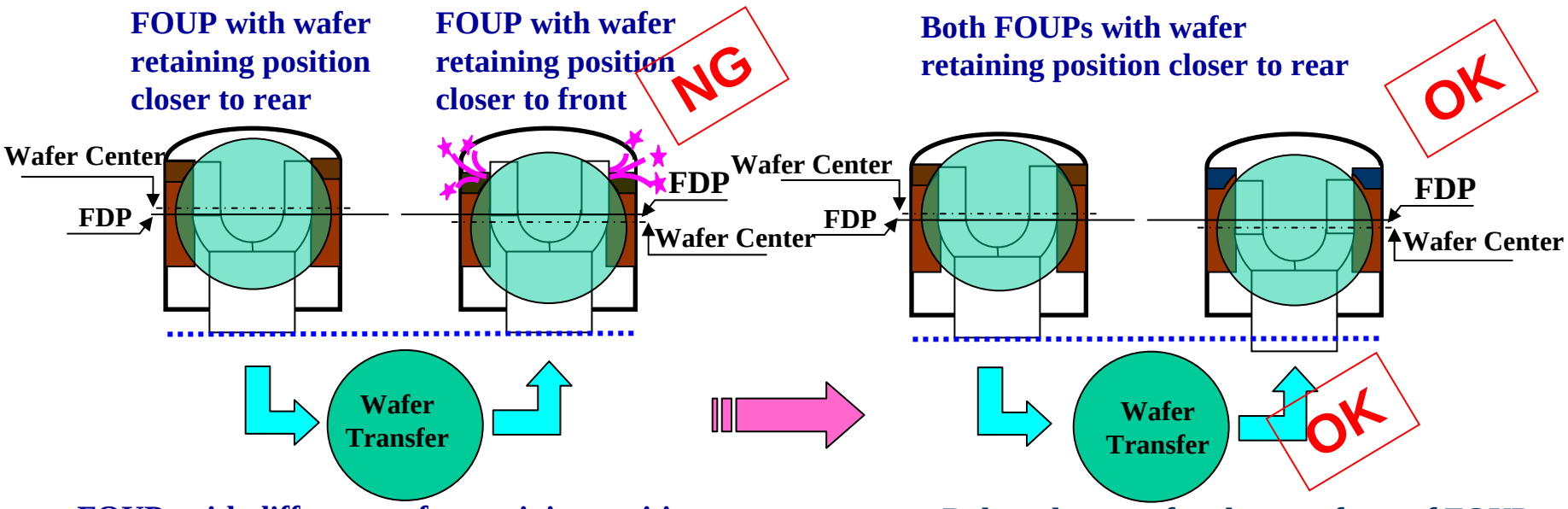
Possible Error



Recommendation



Wafer Center Location in FOUP at Wafer Placement



If the robot is adjusted to a FOUP retaining wafer closer to rear of the FOUP, and then if the robot places wafer into another FOUP to retain wafer closer to front than previous FOUP, wafer edge may hit rear wafer support.

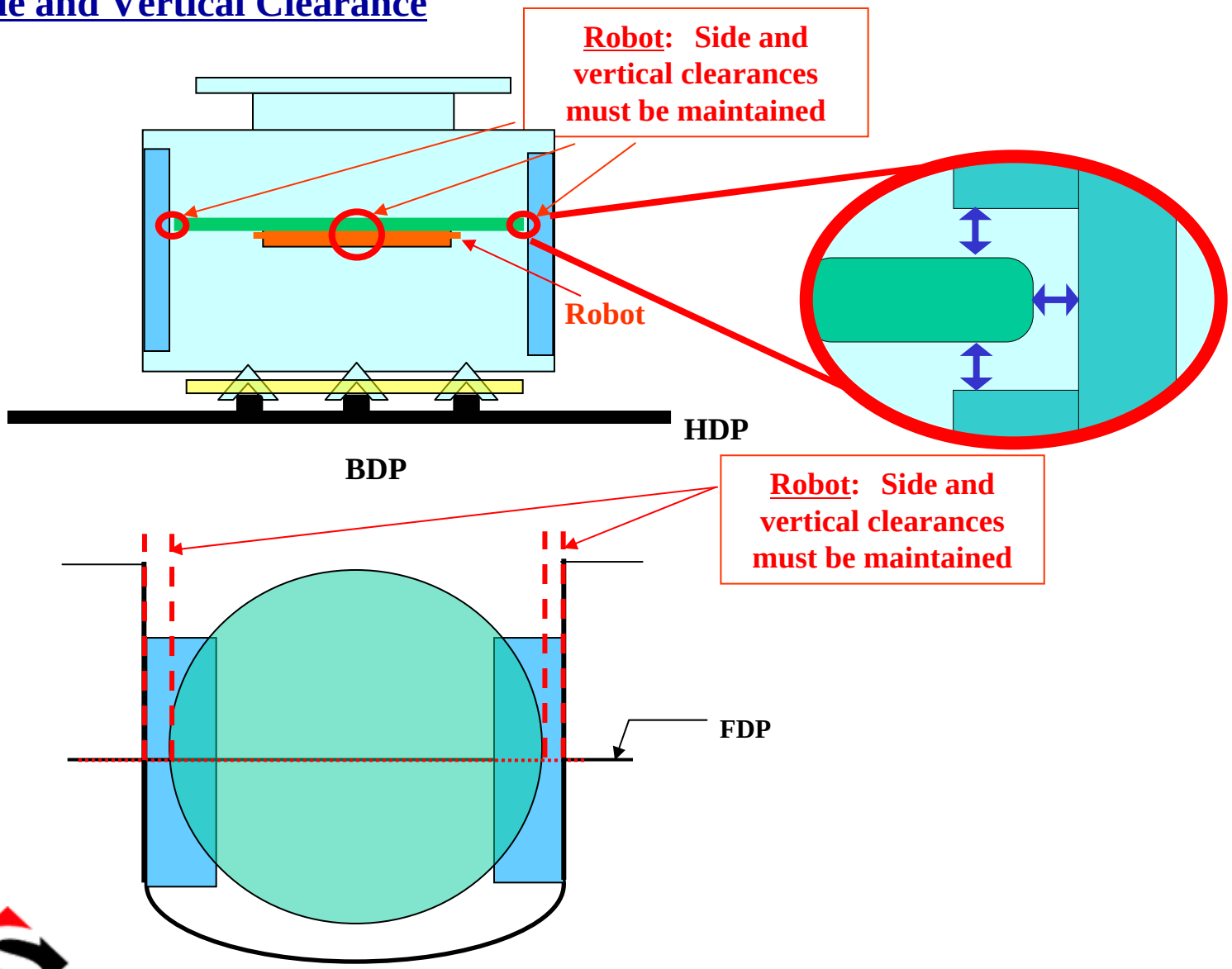
FOUP retains wafer in rear of FDP and Robot places wafer in front of FDP, then wafer edge does not hit rear wafer support.

Robot: Side and Vertical FOUP Clearances Must Be Maintained Upon Wafer Insertion

- **Related USRD:**
  - None
- **Requirement:**
  - To avoid wafer and FOUP collision, side and vertical FOUP clearances must be maintained upon wafer insertion
- **Related Standards:**
  - E1.9, E47.1
- **Impact to Standards:**
  - No change.
- **Application Note:**
  - None.

- **Background:**
  - Wafer may hit FOUP at its placement if;
    - robot is aligned to insert a wafer at an angle from the BDP
- **Approach:**
  - Robot should be calibrated to place wafer at a position so that the side and vertical clearances provided by the FOUP are maintained.
    - Use of calibration tool is recommended instead of calibrating with actual FOUP.

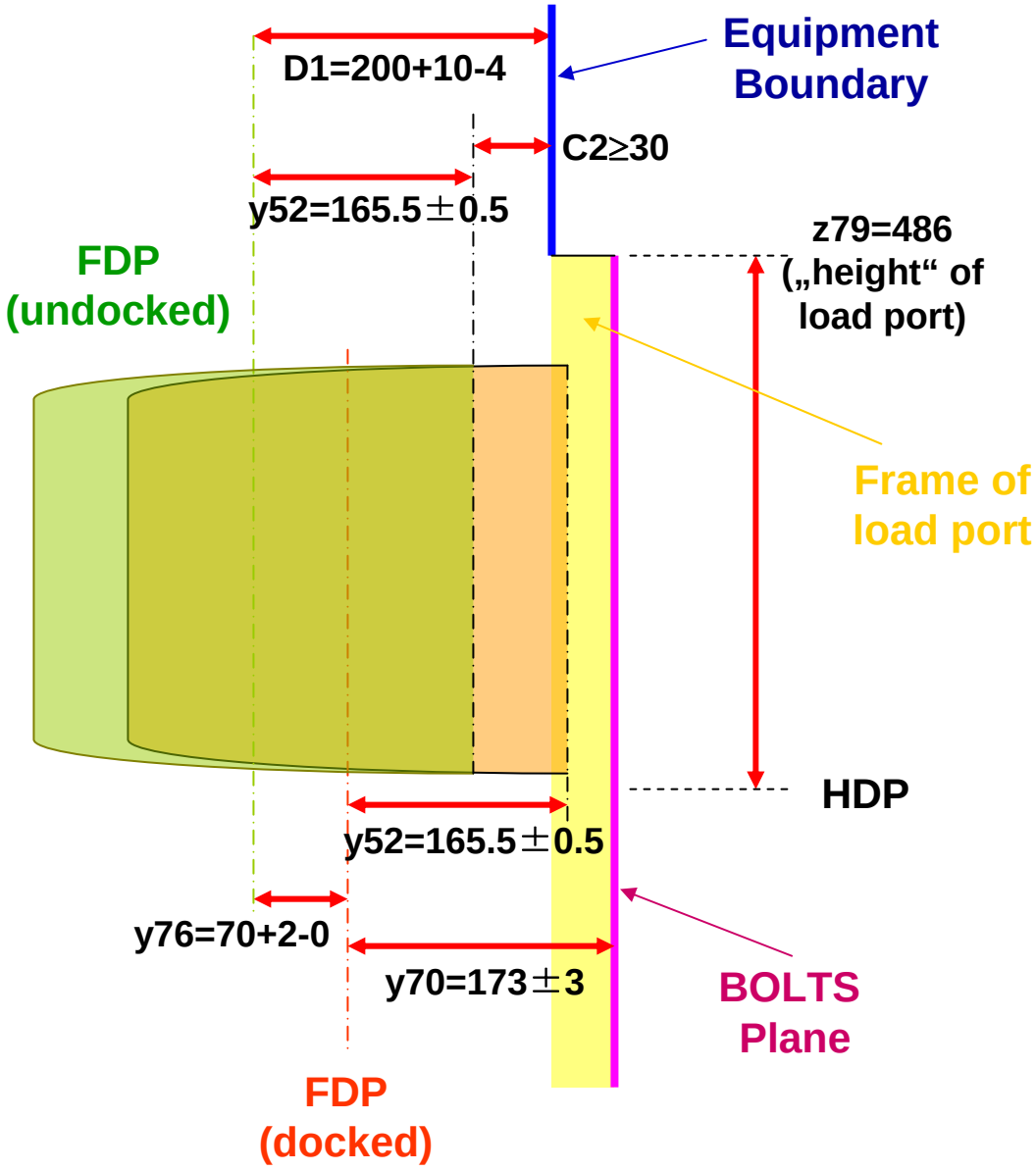
Side and Vertical Clearance



Datum Planes

Load Port: Clarify of BOLTS-Plane versus Equipment Boundary

- **Related USRD:**
  - Clarification was needed to improve readability of E15.1 and E63
- **Requirement:**
  - BOLTS-Plane (E63) and Equipment Boundary (E15.1) are two different entities
- **Related Standards:**
  - E15.1,E63
- **Impact to Standards:**
  - BOLTS-plane has been added to Figure 1 of E15.1 for clarification (by #3542 Line Item 3)
- **Application Note:**
  - Measurement Method:
    Equipment boundary measured by verifying D1 (E15.1) when load port is installed on tool.
- **Background:**
  - BOLTS-plane was originally explained in E63 only and Equipment Boundary in E15.1 only. The location of these different enities needed clarification.
- **Approach:**
  - A line showing the location of the BOLTS plane on the tool side of the Equipment Boundary has been added to E15.1 Figure 1 to clearly identify these different entities.
  - A more sohisticated drawing showing the dimensions from E15.1, E63 and E47.1 related to these two planes is shown on the next page


D1=200+10-4
Equipment Boundary
C2≥30
y52=165.5±0.5
z79=486 („height“ of load port)
FDP (undocked)
Frame of load port
HDP
y52=165.5±0.5
y76=70+2-0
y70=173±3
BOLTS Plane
FDP (docked)

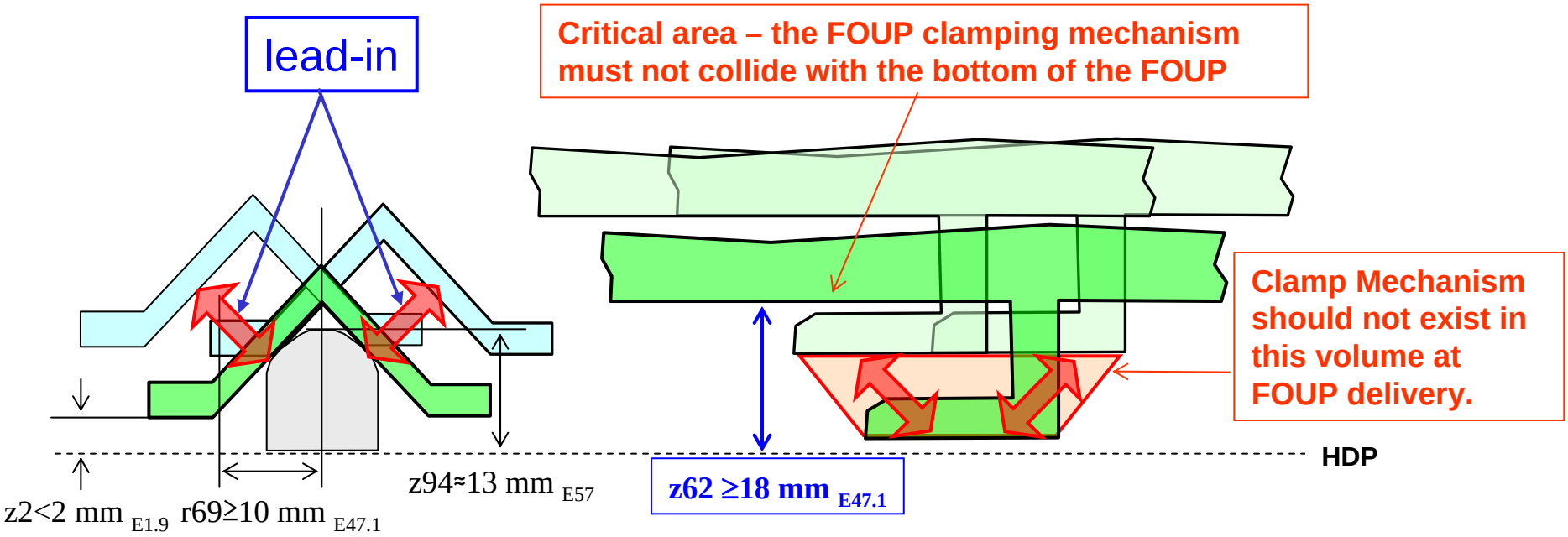
Kinematic Coupling Functionality

Load Port: Interference Between Load Port Features and Kinematic Coupling Lead-in Grooves at the time of FOUP Delivery

- **Related USRD:**
  - None
- **Requirement:**
  - To avoid interference between FOUP and LP features except KC-pins, lead-in function should be considered.
- **Related Standards:**
  - E15.1, E47.1, E57
- **Impact to Standards:**
  - No change
- **Application Note:**
  - None.

- **Background:**
  - Features that extend above the imaginary plane created by the three kinematic pins have been found to compromise the function of the 10 mm lead-in provided by the kinematic coupling.
    - Critical area – the FOUP clamping mechanism must not collide with the bottom of the FOUP
- **Approach:**
  - Ensure that no equipment features compromise the lead-in function provided by the kinematic coupling mechanisms.
- **Note:**
  - The following page presents the interference issue described herein.

Load Port: Interference Between Load Port Features and Kinematic Coupling Lead-in Grooves at the time of FOUP Delivery



New Page

FOUP door drop prevention

Root cause analysis(1/2)

New Page

- Potential factors for FOUP Door drop

Load Port

- LP start latch action at incomplete door close position
  - Shortage of FIMS door closing force
  - Shortage of docking force

FOUP

- Damaged FOUP
- Shortage of FOUP stabilities
- FOUP deformation by
  - High reaction force of :
    - Door seals
    - Wafer retaining

Robot

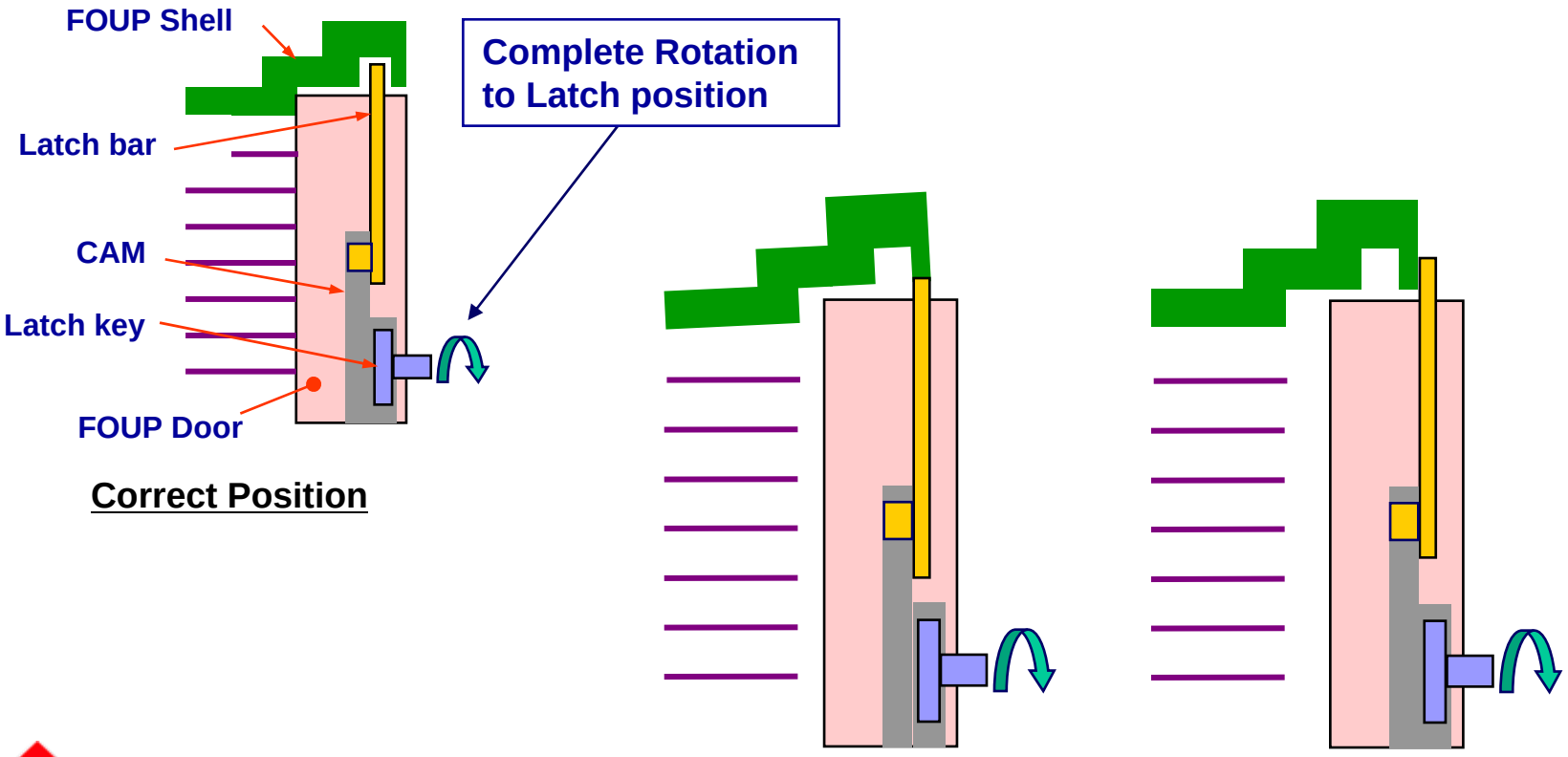
- incorrect wafer unloading position (Door side)

➔Increase reaction force

Root cause analysis(2/2)

New Page

- Possible to detect latch key rotation only



Typical incorrect case (not latched into FOUP)

New Page

Loadport: Confirmation of proper FOUP door close

- **Related USRD:**
  - None
- **Requirement:**
  - To prevent FOUP door drop during FOUP transfer by AMHS, for secure FAB operation.
- **Related Standards:**
  - E47.1, E62
- **Impact to Standards:**
  - No change
- **Application Note:**
  - None.

- **Background:**
  - Detection of latch-key rotational position is not enough to confirm proper FOUP door close.
- **Approach:**
  - Load port to confirm proper FOUP door close by at least following 2 steps.
    1. Locate and confirm the FOUP door to designed position.
    2. Rotate and confirm latch keys to designed position.
- **Note:**
  - Even with above 2 steps approach, complete confirmation of door close can not be realized, because latch bar insertion into FOUP shell can not be directly detected with current latch system.

New Page

FOUP: Avoidance of intermediate state of door open/close

- Related USRD:
  - None
- Requirement:
  - To prevent FOUP door drop during FOUP transfer by AMHS, for secure FAB operation.
- Related Standards:
  - E47.1, E62
- Impact to Standards:
  - No change
- Application Note:
  - None.

- Background:
  - Latch mechanism require many components to satisfy requirement.
  - Due to parts distortion and accumulation of parts allowance, latch bar may not be inserted into FOUP shell properly even latch key turned into correct position.
- Approach:
  - FOUP design to avoid staying at intermediate state of door open/close after latch key rotation.
- Note:
  - None.

Revision History (1.05 to 1.06)

- A revision of charge TF
  - 300mm carrier TF closed. in addition, the FID division was abolished.
- Revise page 2: Contents
  - Add the 450mm FOUP-Load port content
  - Add the Revision History content
- Add page 13: 450mm FOUP-Load port
  - Add the “Good use of this report is recommended as the philosophy of FOUP-Load port interoperability can be reflected onto 450mm FOUP-Load port” sentence
- Revise page 19: Table of Contents
  - Add the ”FOUP door drop prevention” sentence
- Add page 84-88:FOUP door drop prevention
  - Load Port: Confirmation of proper FOUP door close
  - FOUP: Intermediate state of door open/close should not be allowed

Volume 2
Measurement Methods

Contents

- Purpose
- Measurement Methods Development Process
- Position of Documents
- Format Description for Measurement Methods
- Load Port Measurement Methods
- FOUP Measurement Methods

Purpose

- Improve interoperability between FOUP and Load Port
- Provide measurement methods for the assessment of 300 mm FOUP designs.
  - Measurement methods for evaluation of FOUP
  - Suggested measurement gauges for evaluation of FOUP characteristics
  - Measurement procedures
  - Suggest Key items to consider during measurement for enhanced interoperability
  - Remarks
    - FOUP gauge has to be proven by Load Port calibration jigs.
    - FOUP side does not have Standard definitions such as those for FIMS and LP. Suppliers should understand that FOUP dimensions need to be designed to comply with the related Standards such as E62 (Ex. y33, x30, 31, z30, 31 & etc.), E57, and E15.1

Measurement Methods Development Process

- Step 1: Create a "Implementation Report for FOUP/Load Port Interoperability draft" for all issues under discussion by International FLI-SG
  - To: Provide status on the discussions regarding the items in the latest FOUP/Load Port Interoperability Measurement Methods draft.
  - How: FLI-SG to post "FOUP/Load Port Measurement Methods draft" on web-site

- Step 2: Propose Auxiliary document

- Step 3: Suggest creation of / delegation to TFs for SEMI Guide

Position of Documents

- Measurement Methods requires TF activity for SEMI Guide.
  - E47.1
  - E62
    - this may include E57
  - Formation of an International FOUP/Load Port Interoperability TF is planned.

Format Description for Measurement Methods

- Template of an individual issue foil
  - Objective:
    - Measurement purpose
  - Requirement:
    - List of applicable SEMI Standards and symbols
  - Related Standards:
    - List of related or SEMI Standards
  - Procedure:
    - Measurement procedure
  - Application Note:
    - Application notes to apply this recommendation
  - Background:
    - List problems and rationales of this recommendation.
  - Approach:
    - List of approaches or concepts used to solve an issue, along with rationale for the chosen approach
  - Note:
    - Miscellaneous notes

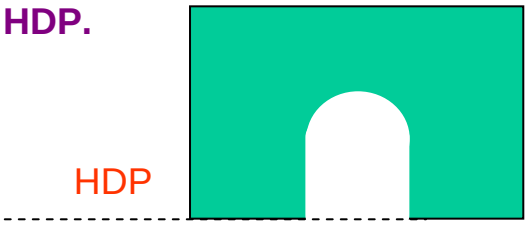
Load Port
Measurement Methods

Contents

- Kinematic Pin Shape - HDP Determination
- Relative Location of the Horizontal Datum Plane (HDP) in the Undocked Position
- Spatial Location of Kinematic Coupling Pins
- Docking Stroke
- y33 of Load Port
- Registration Pin Shape, Dimension, and Position
- Latch Key, Dimension, and Position
- Measurement of FOUP Docking and Door Closing Forces (f33, f34)
- Latch Key Torque Measurement (f30)
- Fixtures referred in Implementation Report for FOUP/Load Port Interoperability

Kinematic Pin Shape - HDP Determination

- **Objective:**
  - To provide an evaluation method for the shape of kinematic coupling pins as well as the exclusion area above HDP to determine SEMI Standard compliance.
- **Related Standards:**
  - E57
- **Requirement:**
  - Measurement of compliance
    - r95, r93 and d91
- **Procedure:**
  - Use the kinematic coupling pin profile gauge.
  - Check the gap between KC-Pin and gauge.
  - Check to ensure there are no obstructions above the HDP.

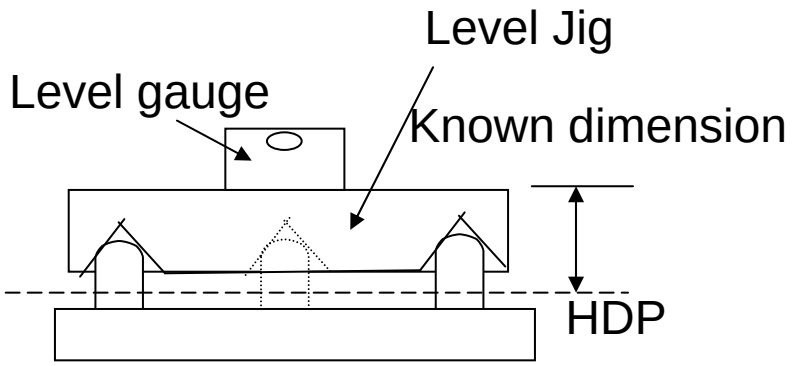


KC-Pin profile gauge

- **Background:**
  - It is difficult to directly measure kinematic coupling pins, so use of gauges is recommended.
    - d91 can be measured (= diameter)
    - Cannot directly measure r93 and r95
- **Approach:**
  - Create gauges for both the lower and upper sides of the tolerances defined in standards on KC-Pins.
  - It is possible to individually measure the shape of each KC-Pin, however it may be more difficult to measure after installation onto Load Port.
- **Note:**
  - Need the surface finish to meet SEMI Standard E57 to ensure appropriate lead-in.
  - It is recommended to use optical projection method for precise measurement of KC-Pins before assembly to Load Plate.

Relative Location of the Horizontal Datum Plane (HDP) in the Undocked Position

- Objective
  - To provide an evaluation method of HDP plane.
- Related Standards:
  - E57, E15.1
- Requirement:
  - Measurement of compliance
    - H in E15.1 and level of kinematic coupling with respect to the associated process equipment
- Procedure:
  - Set the level jig (with V-shaped grooves designed to position FOUP) upon Load Port KC-Pins.
    - Do this at the undocked position.
  - Measure top surface of jig height to determine the HDP (see below).
    - HDP height is calculated from measurement value minus known distance between the top surface of the level jig and HDP. (See right figure)
  - Confirm if the HDP is within the tolerance of E15.1 "H" definition.
  - Put a weight on the level jig to have a total weight of 10 kg, and repeat the measurement.
- Approach
- Note:
  - Relative position of Load Port to be confirmed with the jig at the undocked position.
  - Load Port must provide levelness required by wafer transfer equipment at docked position.
  - The angle of the V-shape jig is important, 90 degrees is preferred. It is not specified in SEMI Standards.



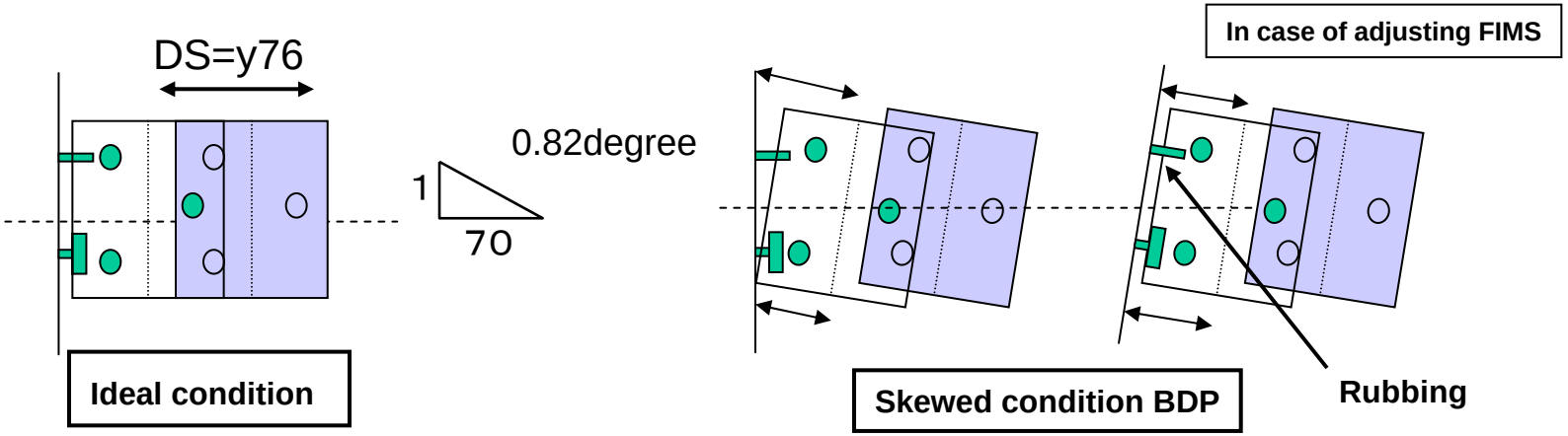
Spatial Location of Kinematic Coupling Pins

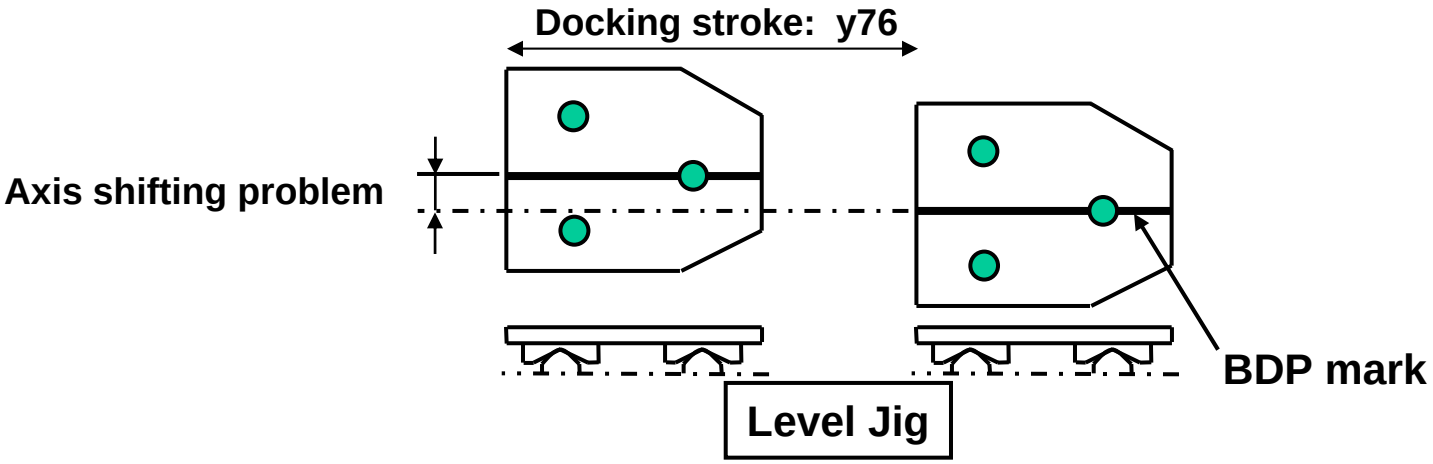
- **Objective**
  - To provide an evaluation method for kinematic coupling pin locations to determine SEMI Standard compliance.
- **Related Standards:**
  - E57
- **Requirement:**
  - Measurement of compliance
    - x91, x92, y91, y92, y93 and y94
- **Procedure:**
  - Jig to be used at shipment test to confirm the location of KC-Pins of Load Port by Load Port manufacturers.
  - Load Port manufacturers should prepare jigs to verify the spatial displacement of KC-Pins.
  - The jig should be consistent with Standard E57: x91 =115 +/-0.05 mm, y91 = 80 +/-0.05 mm, d91 = 12 +/- 0.05 mm
    - Jig not to touch Sensing Pad and Info Pad
- **Background:**
  - Correct understanding of SEMI Standard E57 is required. Manufacturing and shipment test of Load Port for spatial displacement of KC-Pin locations should be performed based on SEMI Standard E57.
- **Approach:**
  - Easy and repeatable check method is suggested.
- **Note:**
  - Tighter tolerance at jig to be designed to minimize distribution by Load Port manufacturer.
  - Another check is suggested for the relationship between FDP or BDP and BOLTS plane.
  - The tolerance of the E57 Standard may lead to y33 (FOUP) variation of up to 200 um.
    - See : y33 - FOUP Perpendicularity chart on page 31
    - See: Approved Kinematic Coupling Plate (KC-Plate) on pages 25-26

Docking Stroke

- Objective
  - To provide a docking stroke evaluation method of Load Port advance mechanism to determine SEMI Standard compliance.
- Related Standards:
  - E57, E63
- Requirement:
  - Measurement of compliance
    - y76
- Procedure:
  - Set jig on Load Plate on Load Port.
  - Guarantee parallelism between BDP and Load Plate rail.
  - Keep nominal value of adjustment tolerance at the undocked position for the AMH system.
  - BDP marks should be marked on the block gauge with V-shaped groove. Evaluate the deviation by docking operation.
  - y76 should be measured by a slide caliper simultaneously.
    - f33 should be measured at the same time.
- Background:
  - AMH transfer problem due to inconsistent undock position.
  - Axis shifting problem. (Refer to the figure in the following page)
- Approach:
- Note:

Docking Stroke (continued)





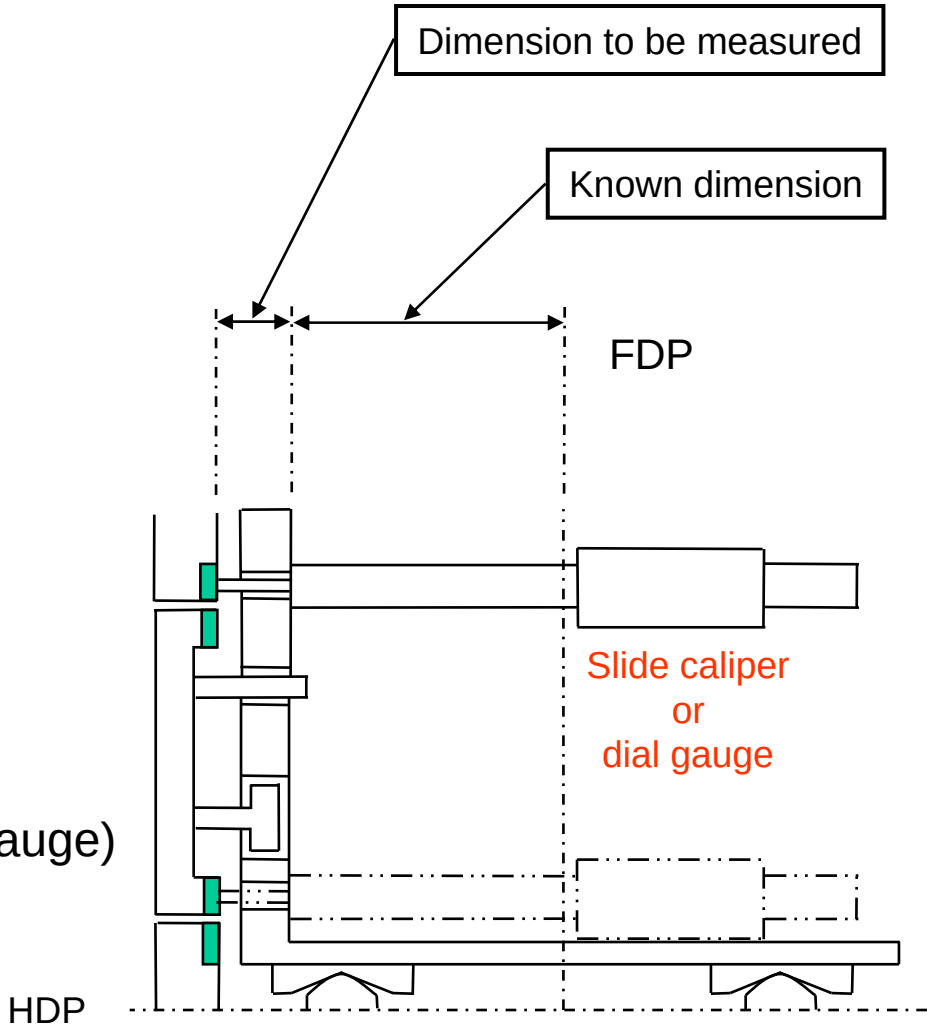
y33 of Load Port

- **Objective**
  - To provide evaluation method for Load Port y33 dimension to determine SEMI Standard compliance.
- **Related Standards:**
  - E62, E47.1
- **Requirement:**
  - Measurement of compliance
    - y33 (FIMS door), y33 (FIMS Frame)
- **Procedure:**
  - Set the L-type gauge with V-shaped groove onto KC-Pin. Measure the dimension from FDP (as shown on the following page)
    - Calculate the dimension using known dimension by slide caliper
  - Measure the y33 dimension on Load Port FIMS door and Load Port Frame
    - Either FIMS door and/or Load Plate should have some adjustment tolerance.
  - Calculate the angle of FIMS door and Load Port Frame from FDP and BDP based on y33 dimension.
    - Perpendicularity from BDP
    - Parallel from FDP
    - Consider the pressed tolerance when elastomer is used at the seal zone in the case sealing material is used. This case has to be studied further.
  - Do not apply excess force onto FIMS door during the measurement process.
    - FIMS door has compliance designed in to allow for a cushioning effect when the advance mechanism moves near or against prior to opening of FOUP.

y33 of Load Port (continued)

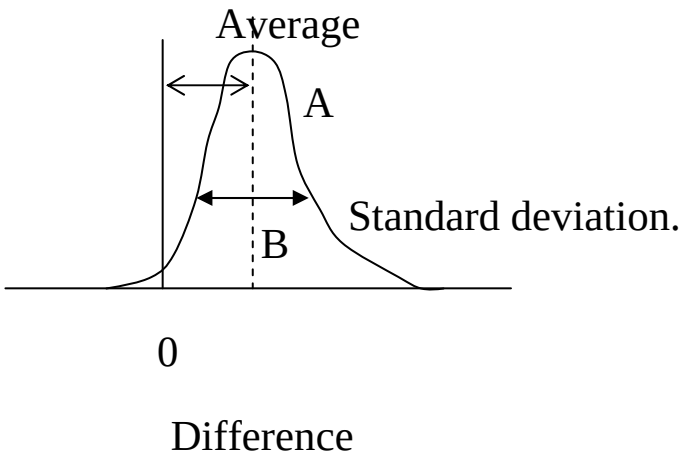
- **Background:**
  - **y33 of FOUP and y33 of FIMS have the same specification, which causes opening and closing problems.**
  - **In order for the y33 of FOUP to be considered the base reference in the future, Load Ports will be measured accordingly.**
- **Approach:**
- **Note:**
  - **y33 of Load Port Frame should be a reference, because FIMS door surface moves**
    - **y34 should have negative tolerance, which means FIMS door surface of FIMS jumps out of Load Port Frame.**

L type gauge.
(FIMS evaluation gauge)



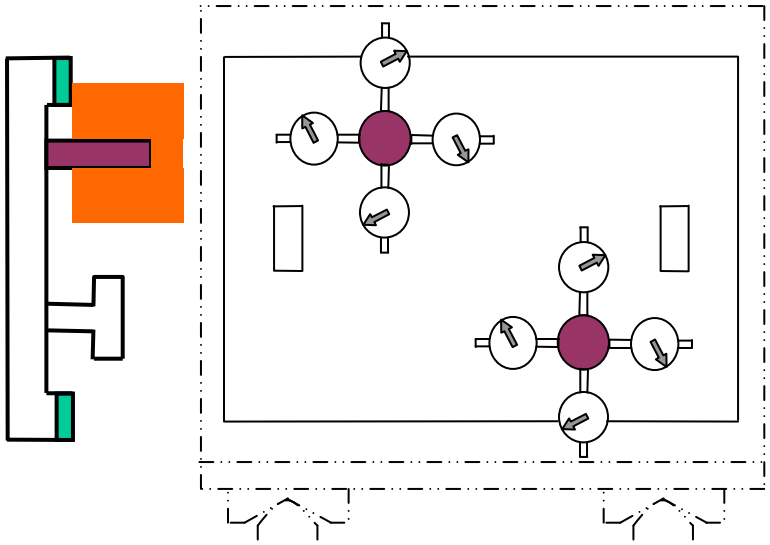
Registration Pin Shape, Dimension, and Position

- Objective
  - To provide an evaluation method for Load Port Registration Pin to determine SEMI Standard compliance.
- Related Standard
  - E62
- Requirement:
  - Measurement of compliance
    - x31, z31, d31 and z30 (CL)
- Procedure:
  - (1)Set L-type gauge with V-shaped groove onto KC-Pins.
  - (2) Put a weight on the L-shape jig to have a total weight of 10 kg on LP. The weight should be placed as close to the FDP/BDP intersection as is possible.
  - (3)Move the LP's advance mechanism to the docked position and measure the LP position error from E62 standard positions x31, x30, z30 and z31.
  - (4)Open the FIMS door (without FOUP door) and move down.
  - (5) Return the FIMS door to its original position and close.
  - (6)Go to (3) and repeat the LP door position measurement at least 5 times.
  - (7)Calculate average and standard deviation.
    - The average value reveals the position error of the LP door. The standard deviation reveals the repeatability LP door measurement.
  - Measure the position from BDP & HDP (as shown on the following page)
    - FIMS door and/or Load Plate should have some adjustment tolerance
      - –L-type gauge can be shared with y33 gauge.



Registration Pin Shape, Dimension, and Position (continued)

- Registration Pin shape evaluated by using the go/no-go gauge
  - Measure from FIMS door surface
  - d91 can be measured by slide caliper.
- **Background:**
  - The largest issue is if during docking, FIMS door surface and FOUP Door surface can not mate. FIMS door (Registration Pin) needs to be within the E62 definition.
- **Approach:**
- **Note:**
  - Registration Pin Holes of FOUP will become larger
    - Suppliers should not make thin Registration Pins.
  - Vacuum seal area caution
    - Use caution around packing and vacuum cup areas during measurement.
  - FIMS door adjustment should first be done using Registration Pins. Latch Key adjustment is difficult due to the rotational center offset measurement

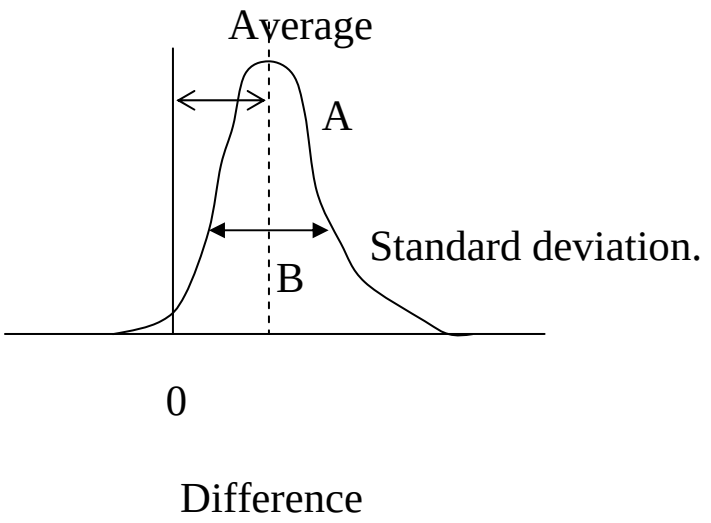


Registration Pin profile gauge

L type gauge. (FIMS Evaluation gauge)

Latch Key, Dimension, and Position

- **Objective**
  - To provide evaluation method of Latch Key to determine SEMI Standard compliance.
- **Related Standard:**
  - E62
- **Requirement:**
  - Measurement of compliance
    - x30, z30, x36, r36, y36 and y37
- **Procedure:**
  - (1)Set L-type gauge with V-shaped groove onto KC-Pins.
  - (2)Put a weight on the L-shape jig to have a total weight of 10 kg on LP. The weight should be placed as close to the FDP/BDP intersection as is possible.
  - (3)Move the LP's advance mechanism to the docked position and measure the LP position error from E62 standard positions x30 and z30.
  - (4)Open the FIMS door (without FOUP door) and move down.
  - (5) Return the FIMS door to its original position and close.
  - (6)Go to (3) and repeat the LP door position measurement at least *5* times.
  - (7)Calculate average and standard deviation.
    - The average value reveals the position error of the LP door. The standard deviation reveals the repeatability LP door measurement.



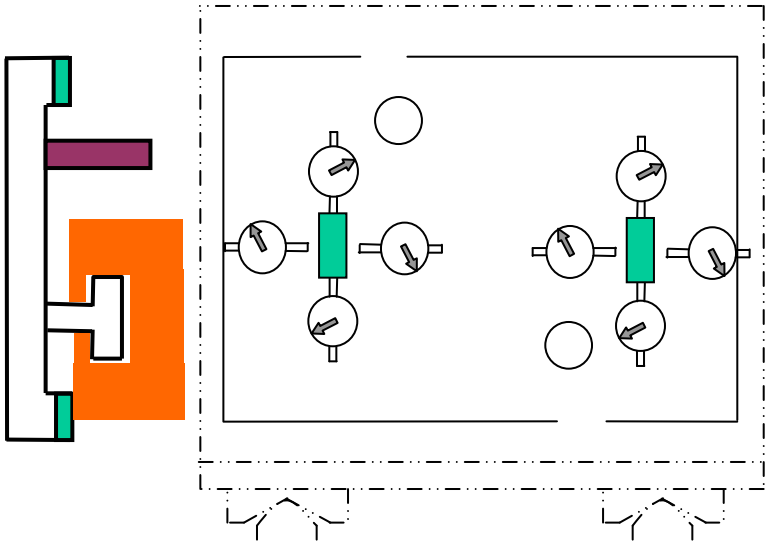
Latch Key, Dimension, and Position (continued)

- Measure Latch Key from BDP and HDP (as shown on the following page)
  - FIMS or Load Plate should have adjustment tolerance
    - L-type gauge can be shared with y33 gauge.
- Use go/no-go gauge
  - Measure from FIMS door surface
- Need coincidence of the center dimension and rotational center.
- Measure y37 by using thickness gauge.
- Measure Latch Key width by using slide caliper.

- **Background:**
  - If the Registration Pin Holes become larger, Latch Keys will rub Latch Key Hole.
  - A "bad" Latch Key may create Latch Key Hole redundant angle problem.
    - Lack of rotation angle
    - Lack of Latch Key width Approach:

- **Note:**
  - Expect new Latch Key specifications and changes in E62 (tolerance, radius, etc).

- If Latch Key Holes have margins that are too large (Latch Key width +/-0.2 mm : x36), Latch Key mechanisms cannot be sufficiently returned to their original position by Load Port side of the interface.
- r41 is difficult to measure since r41 may effect lead-in. Confirm r41 value.

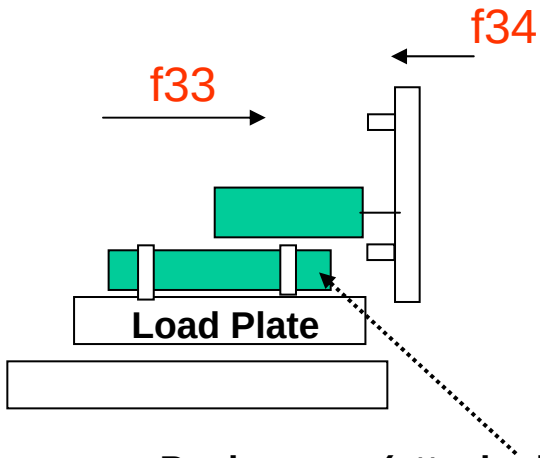


Latch Key profile gauge

L type gauge. (FIMS Evaluation gauge)

Measurement of FOUP Docking and Door Closing Forces (f33, f34)

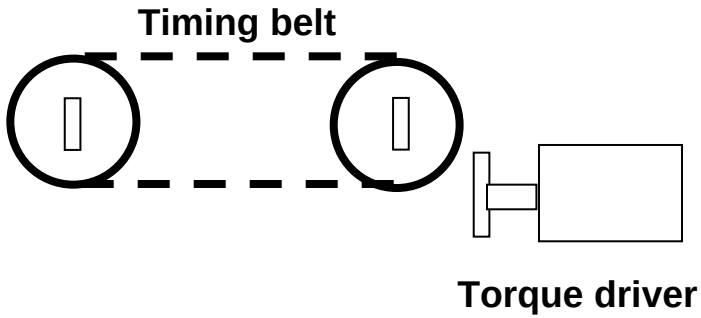
- **Objective**
  - To provide an evaluation method for FOUP docking and Door closing forces to determine SEMI Standard compliance.
- **Related Standard:**
  - E62
- **Requirement:**
  - Measurement of compliance
    - f33 and f34
- **Procedure:**
  - Measure the moving Load Plate by using push gauge.
  - Measure around the moving FIMS door center by using push gauge.
  - For f33
    - Set jig on KC-Pin of undocked position.
    - Let it advance Load Plate to its docked position and measure maximum force.
  - For f34
    - Let FIMS door go back to the opening position
    - set jig on KC-Pin of docked position.
    - Let FIMS door go forward to the closing position and measure maximum force.
- **Background:**
  - The equipment has a defined stopping point, so there is no need for an upper limit.
- **Approach:**
- **Note:**
  - Be cautioned that this standardized number may be revised.



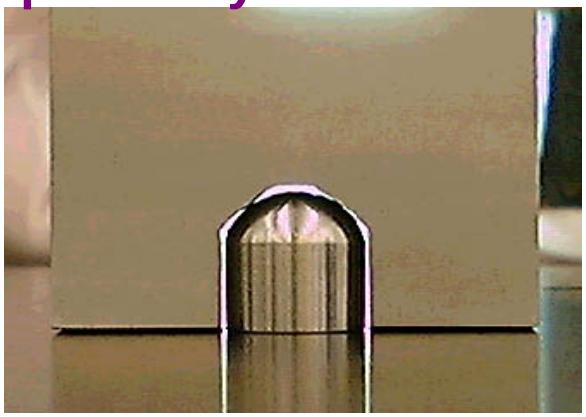
Push gauge (attached KC-Pin)
For f33,f34

Latch Key Torque Measurement (f30)

- **Objective**
  - To provide an evaluation method for torque required to rotate a Latch Key mechanism.
- **Related standard:**
  - E62
- **Requirement:**
  - Measurement of compliance
    - f30
- **Procedure:**
  - It is recommended to measure both Latch Key mechanisms simultaneously
  - Use an adaptor which mates with Latch Key,
  - Measure directly with a torque meter.
- **Background:**
  - There is no need for an upper limit value to be placed on f30, as each Latch Key mechanism may have stop points at both rotated sides.
  - When Latch Keys and Latch Key Holes are off centered, excessive burden is borne.
- **Note:**
  - If simultaneous torque measurement is not performed, an individual measurement should be secured for each Latch Key.
    - If a common driving source is used for both of Latch Keys, the torque value may be halved and used for reference.
  - Latch Key rotation supply torque has to be more or equal to 1.7Nm for each Key towards to both direction.
    - In a case where two Latch Keys are rotated with one drive axis, Latch Key torque that is more or equal to 1.7 Nm for each Latch Key has to be confirmed.



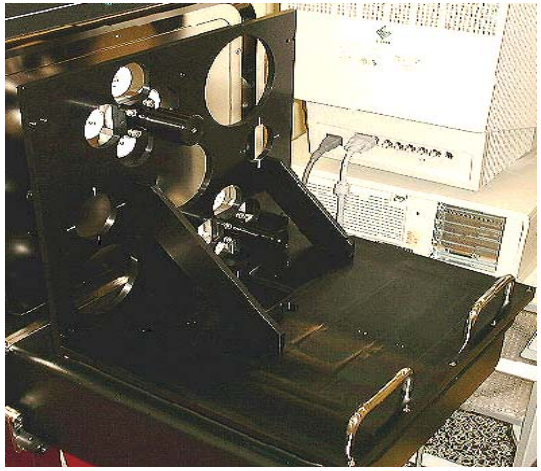
Fixtures referred in Implementation Report for FOUP/Load Port Interoperability



KC-Pin profile gauge

KC-Pin location evaluation jig

Horizontal Datum Plane (HDP) jig



FIMS evaluation jig

These jigs (and others) are commercially available.

FOUP
Measurement Methods

Contents

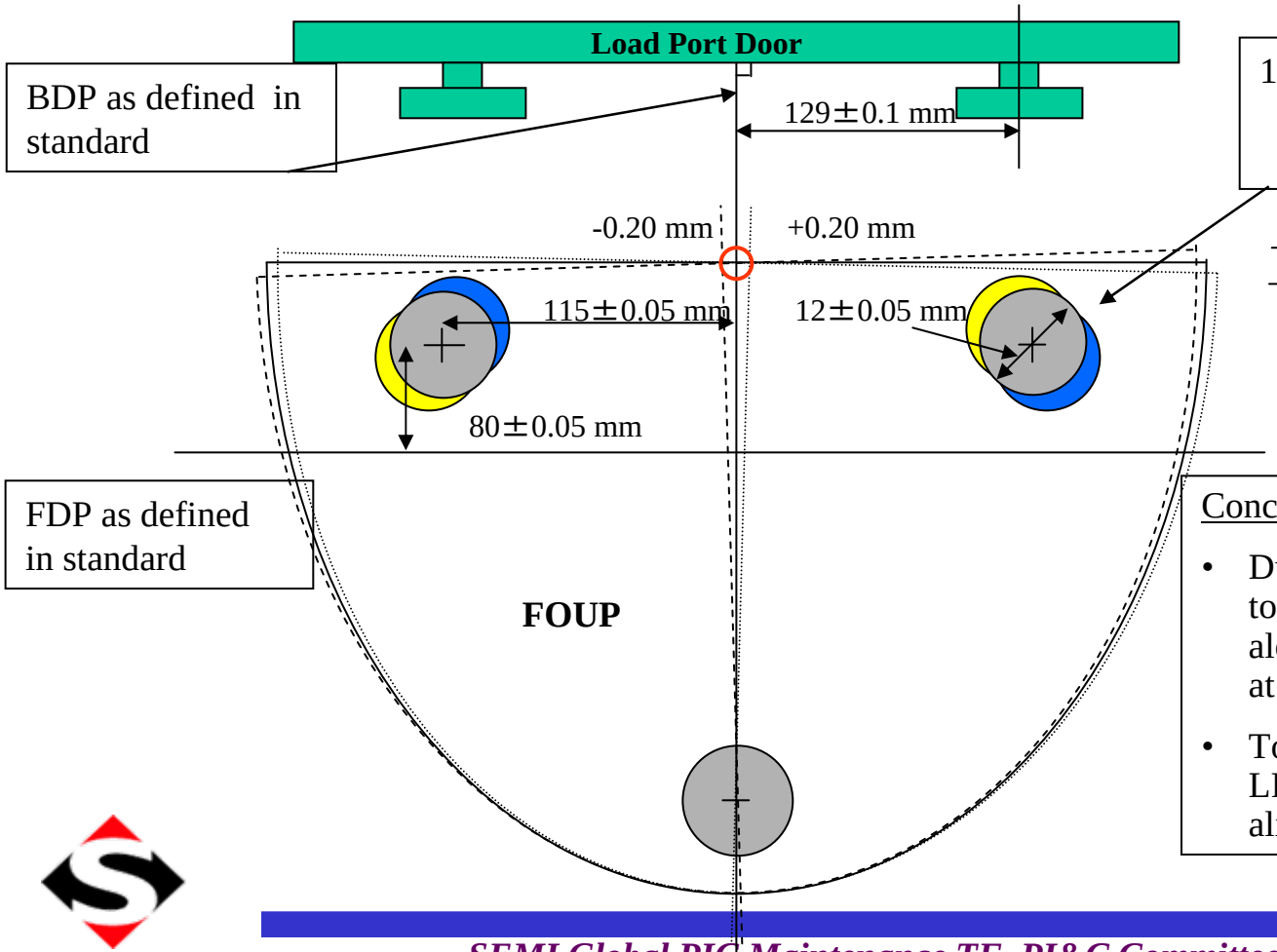
- Approved Kinematic Coupling Plate (KC-Plate)
- Wafer Plane by Using a Perfect Flat Wafer
- Wafer Plane Measurement using a Prime Wafer
- Wafer Center Location
- Shape and Position of Latch Key Holes
- Shape and Position of Registration Pin Holes
- y52 (FOUP) and Perpendicularity
- Necessary Torque for Latch Key Mechanism Rotation (f30)

Approved Kinematic Coupling Plate (KC-Plate)

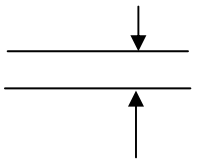
- Object
  - KC-Plate used for FOUP measurement should be approved for its accuracy according to the measurement methods shown for Load Port measurement but with narrower tolerances which are shown in requirement in this foil.
- Related Standard
  - E57
- Requirement
  - Shape of KC-Pin
    - E57: r95 with +/- 17 μm tolerances
  - Location of KC-Pin
    - E57: X91, y91 both with +/- 17 μm tolerances
  - Level of KC-Pin
    - Height : Surface of the level jig within +/- 50 μm
- Procedure
  - Refer LP measurement methods
  - Shape of KC-Pin : Use optical projection method for precise measurement of KC-pins before assembly to KC-Plate.
- Background
  - KC-Plate with SEMI Standard may have as much as +/- 85 μm variation in y33.
  - The rule of thumb is variation of KC-Pin location may yield as much as 1.7 times variation in y33 (FOUP).
  - The current KC-Plate Jig used at Selete has tolerance of 2 μm (verified).
- Notes
  - The measurement error induced due to KC- Plate should be less than 10%of the tolerance for the relevant dimension.
  - Since y33 tolerance is +/-0.5mm, the error introduced by KC-Plate should be less than +/-50 μm.
  - In order to have less than +/-50 μm measurement error due to KC-Plate, KC-Pin location error should be within +/-29 μm.
  - The y-axis gap model (refer page 35 in vol.1) may have to deal with +/-0.3mm tolerance, and this would require less than +/-30 μm of error induced by KC-Plate.
  - For less than +/-30 μm error in y33 measurement, KC-Pin location error has to be within +/-17 μm.
  - Likewise as the wafer planes are required within +/-0.5mm, the height error of KC- Plate should be less than +/-50 μm.

Approved KC-Plate (continued)

- **Current SEMI Standard E57 can lead to y33 variation based upon the position of KC-Pin/FOUP from FIMS door.**



1) Tolerance of KC-Pin position and KC-Pin size as define in Standard



0.17mm

Conclusion:

- Due to the stack-up of the tolerance, the rotation of FOUP along the BDP can vary +/-0.20mm at the point marked with the O
- To correct this issue, the setup of LP should be performed with an alignment jig simulating a FOUP.

Wafer Plane by Using a Perfect Flat Wafer

- **Objective:**
  - To provide evaluation method for wafer planes to determine SEMI Standard compliance.
- **Related Standards:**
  - E47.1, E1.9
- **Requirement:**
  - Measurement of compliance
    - z8(FOUP), z12, & z10 by using perfect flat wafer
- **Procedure:**
  - Use a test substrate without sag (e.g., ceramics, glass, etc.)
    - Flatness : No more than 10 mm
    - Thickness : Less than 4 mm
  - Set FOUP onto KC-Plate Jig. A Coordinate Measurement Machine (CMM) will be required
  - Calculate flatness from measurement at more than 3 points on the lower surface of the test substrate since the lower surface is cited in standard.
    - When it is impossible to measure the lower surface of a dummy wafer, it is possible to measure the upper surface of the dummy wafer.
  - This method is an example which utilizes CMM. If other equipment (digital method or optical method) is to be used, a correlation with the CMM should be performed.
- **Background:**
  - First, the wafer plane should be confirmed with a perfectly flat wafer. If the carrier fails this test, it may fail with prime wafers.
  - Normal Si wafers are not suitable to do this measurement.
- **Approach:**
- **Note:**
  - Test substrates can not be handled with wafer handling mechanism for normal Si wafers. The test substrates are to be placed within r2 so as to eliminate the test substrate edge from overriding the side wall.
  - Alumina ceramic wafers must be thicker than 2.7 mm to reduce sag less than 10 mm.
  - Jig which is designed to be conformant with SEMI E57 but with narrower tolerances.
  - Approved KC-Plate is a jig designed to be conformant with SEMI E57 but narrow tolerances (refer to pages 25-26).

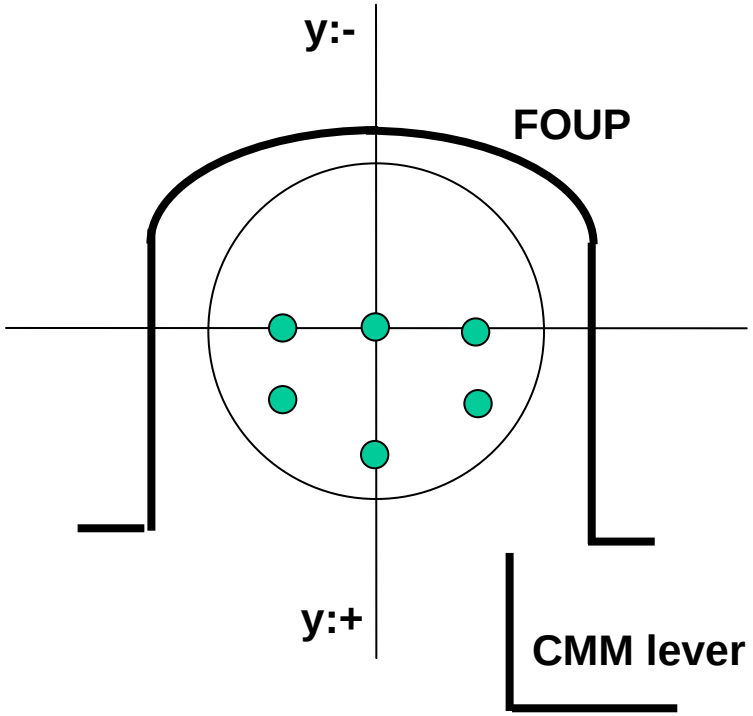
Wafer Plane Measurement using a Prime Wafer

- **Objective:**
  - To provide an evaluation method for wafer planes to determine SEMI Standard compliance.
- **Related Standards:**
  - E47.1, E1.9
- **Requirement:**
  - Measurement of compliance
    - z8 (FOUP), z12, and z10 by using real Si wafer
- **Procedure:**
  - Use a mechanical wafer
    - prime wafer
  - Set FOUP onto KC-Plate Jig. A measurement with a Coordinate Measurement Machine (CMM) is suggested
  - Calculate flatness from measurement at multiple points on the lower surface of the wafer so that a curved plane can be defined. Refer to the table on the following page for the suggested measurement points.
    - When it's impossible to measure the under surface of flat plate, measuring on the upper surface of flat plate is allowed.
  - This method is an example which utilizes CMM. In the case of other equipment (digital method or optical method), a correlation with CMM should be performed.
- **Background:**
  - First, the wafer plane should be confirmed relative to the perfect flat wafer. If the carrier does not pass that test, it may fail with real wafers.
  - Since Silicon wafer sag can vary, the sag has to be well considered.
- **Note:**
  - Carrier designs that yield smaller variances between flat wafer seating planes and prime wafer seating planes are preferred.
  - Approved KC-Plate is a jig which is designed to be conformant with SEMI E57 but narrow tolerances(refer to pages 25-26)

Wafer Plane by real wafer (continued)

Measurement points (recommend)

x	y
0	0
0	+145
+/- 120	0
+/- 120	+ 80



Current CMM can not measure points near the rear side of FOUP.
If measurement capability is developed for the rear side of FOUP, this measurement method could be revised accordingly to include these points.

Wafer Center Location

- **Objective**
  - To provide an evaluation method for coaxiality between wafer center location and carrier wafer sitting plane center location.
- **Related Standards:**
  - E1.9, E47.1
- **Requirement:**
  - Measurement of difference between the wafer center and the carrier center.
- **Procedure**
  - Use a test substrate without sag (e.g., ceramic, glass, etc.)
    - Diameter : Complied to SEMI M1.15
    - Flatness : No more than 10 um
    - Thickness : Less than 4 mm
  - Set FOUP onto an approved KC-Plate Jig. A Coordinate Measurement Machine (CMM) will be required
  - Measure the center location of the test substrate while on the wafer supports.
    - Measure after FOUP Door is removed.
    - Do not press wafers against rear support to prevent wafer from creeping up to the wall.
    - Measure distance from FDP to the wafer edge point in BDP
- **Background:**
  - Avoid any damage to wafer when it is inserted into FOUP.
- **Note:**
  - Care should be taken to perform this measurement in a condition that prevents the wafers from colliding with the rear supports of FOUP.
  - If mechanical grade wafer is used, it should be taken into consideration that a wafer can have any amount of sag within specification.
  - Approved KC-Plate is a jig designed to be conformant with SEMI E57 but narrow tolerances (refer to pages 25-26).

Shape and Position of Latch Key Holes

- **Objective:**
  - To provide an evaluation method for Latch Key Hole shapes and location.
  - To measure the shape and position of Latch Key Holes relevant to standard dimensions of the assoiated Load Port interface.
- **Related Standard:**
  - E62, E47.1
- **Requirement:**
  - Measurement of relevant dimensions for FIMS compliance
    - z30, x30 in defined E62
- **Procedure**
  - Set FOUP onto an approved KC-Plate Jig, a CMM will be required
    - Measure the width (x, z dimension) inside Latch Key Hole.
    - Find the center of Latch Key Hole from its width dimension.
    - Measure the depth (y dimension) of Latch Key Hole from the surface of FOUP Door.
- **Application Note:**
  - Measure Latch Key Hole sizes and positions with centering FOUP Door with external equipment or a similar method. The width and the center should be measured at a position of y33 and/or y36.
  - Latch Key Hole depth can be measured by removing FOUP Door from FOUP shell.
- **Background:**
  - Latch Key sometimes hits the fringe of Latch Key Hole and does not enter the Hole.
  - Even if the inserted Latch Key rotates, the Door does not smoothly open or close.
- **Approach:**
- **Note:**
  - Latch Key Hole width, chamfer, taper, and flexibility (sloppiness) are designed at suppliers discretion.
  - Approved KC-Plate is a jig designed to be conformant with SEMI E57, but narrow tolerances (refer to pages 25-26).

Shape and Position of Registration Pin Holes

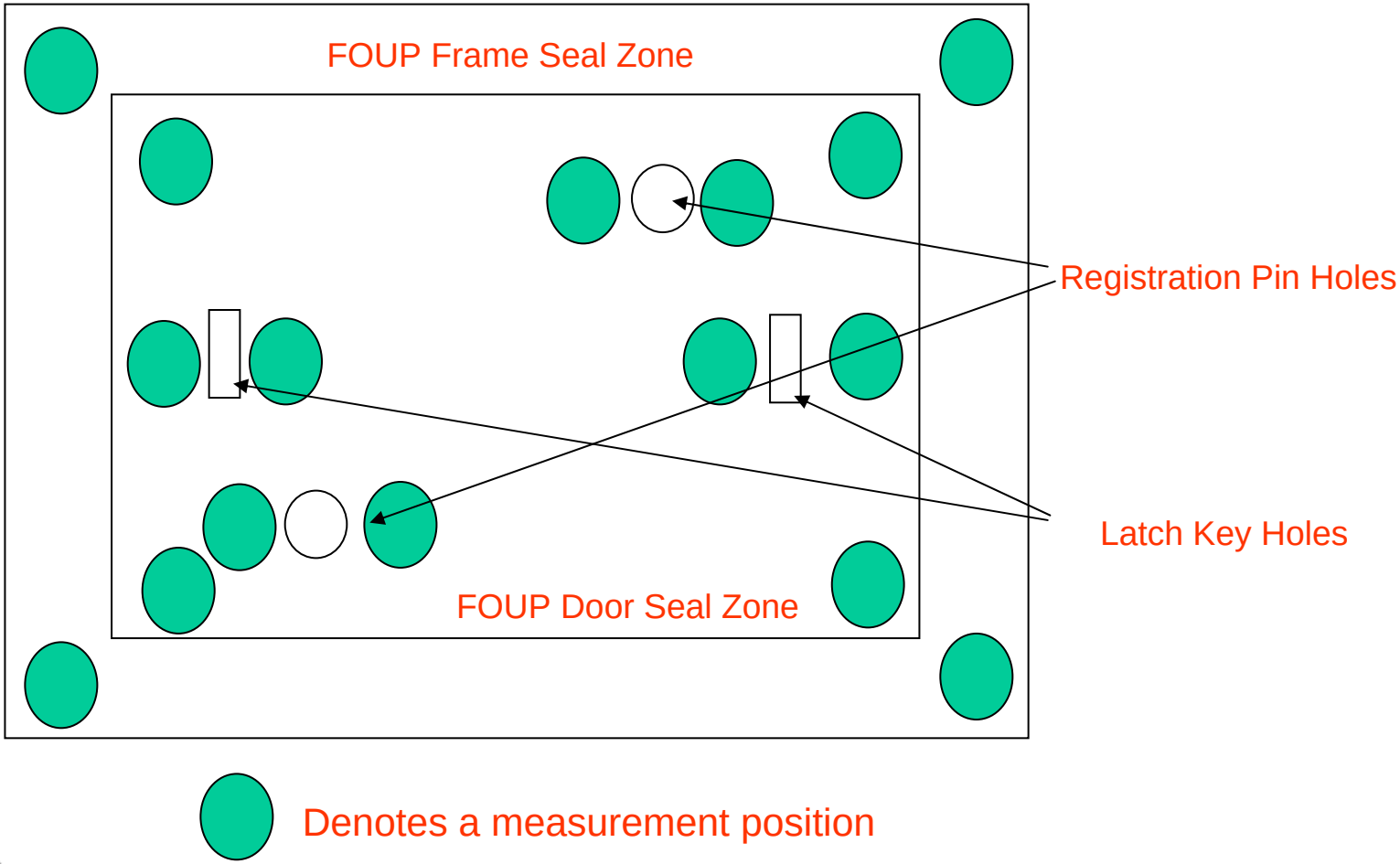
- **Objective**
  - To provide an evaluation method for Registration Pin Hole position.
  - To measure the shape and position of Registration Pin Holes relevant to standard dimension of the assoiated Load Port interface.
- **Related Standard:**
  - E62, E47.1
- **Requirement:**
  - Measurement of relevant dimensions for FIMS compliance
    - z30 +-z31, x31 in defined E62
- **Procedure:**
  - Set FOUP onto an approved KC-Plate Jig, a Coordinate Measurement Machine (CMM) will be required
    - Measure the diameter inside Registration Pin Hole.
    - Find the center of Registration Pin Hole from its diameter.
    - Measure the depth (y dimension) of the Registration Pin Hole from the surface of FOUP Door.
- **Application Note:**
  - Measure Registration Pin Hole sizes and positions by centering the Door with alignment equipment or similar methods.
  - The diameter and the center should be measured at a position of y33 and/or y36.
  - The depth can be measured by removing Door from FOUP Door surface.
- **Background:**
  - Registration Pin sometimes hits the fringe of Registration Pin Hole and does not enter to Registration Pin Hole.
  - Even if Registration Pins go into Registration Pin Holes with rubbing, FOUP Door very likely will not mate with FIMS door.
- **Approach:**
- **Note:**
  - Registration Pin Hole diameter and taper are designed at suppliers discretion.
  - Approved KC-Plate is a jig which is designed to be conformant with SEMI E57 but narrow tolerances(refer to pages 25-26).

y52 (FOUP) and Perpendicularity

- Objective:
  - To provide an evaluation method for distance between FDP and FOUP Door/ FOUP Frame
- Related Standards:
  - E47.1, E62
- Requirement:
  - Measurement of y52
- Procedure
  - Set FOUP onto KC-Plate. A Coordinate Measurement Machine (CMM) will be required
    - For FOUP Door and FOUP Frame individually
    - On the basis from FDP
  - Measure perpendicularity of FOUP from y52 measurement data
    - For FOUP Door and FOUP Frame
  - Flatness should be calculated with perpendicularity
  - Measurement should be done both with FOUP unloaded and fully loaded with wafers.
  - For FOUP Door
    - Twelve points in vacuum application zones around Registration Pin Holes, seal zone, and around Latch Key Holes (See next figure)
  - For FOUP Frame
    - Four points on Load Port Frame Seal Zone (see Next figure)
- Background:
  - y33 (FOUP) is a Key dimension for reliable FOUP Door engagement by FIMS.
  - Poor perpendicularity of FOUP Door sometimes causes FIMS door docking trouble.
- Approach:
- Note:
  - FDP and BDP should be determined based upon kinematic pins
  - Parallelism between base plate of the CMM and KC-Pin level should be maintained during measurement.
  - Approved KC-Plate is a jig which is designed to be conformant with SEMI E57 but narrow tolerances(refer to pages 25-26).

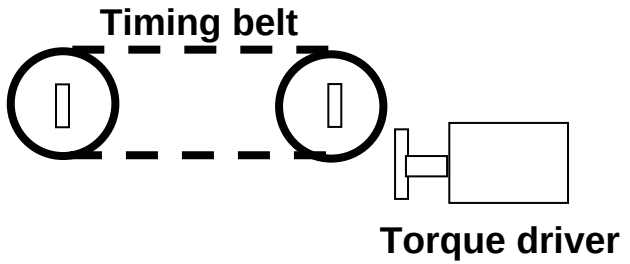
y33 (FOUP) and Perpendicularity (continued)

This figure shows FOUP Door side



Necessary Torque for Latch Key Mechanism Rotation (f30)

- **Objective:**
  - To provide an evaluation method for torque required to rotate FOUP Latch Key mechanisms
- **Related Standard:**
  - E62, E47.1
- **Requirement:**
  - Measurement of f30
- **Procedure:**
  - It is recommended to carry out measurement for both of Latch Key mechanisms at the same time.
  - Use torque meter with a Latch Key shaped adapter.
  - Measure to confirm the rotation torque for either Latch Key Hole is less than 1.7 Nm (defined as f30 in E62) for opening and closing.
  - Measurement should be done with FOUP fully loaded with wafers.
- **Background:**
  - Some FOUPs need much more torque than others.
  - Required force maximum occurs when Latch mechanism of FOUP Door is fully tightened to support FOUP Door in FOUP Frame while FOUP Door pushes the wafers into FOUP by retainers. Therefore the required torque should be the measure of this maximum torque needed.
  - When the centers of Latch Keys and Latch Key Holes do not coordinate, excessive force is necessary unless otherwise flexibility (sloppiness) of Latch Key Hole is available.
- **Note:**
  - If simultaneous torque measurement is not performed, an individual measurement should be performed for each Latch Key.
  - Load Port should offer more than 1.7 Nm for rotational torque.



Revision History (1.05 to 1.06)

- No Change in Measurement method